REPORT OF

Fourteenth Annual

Date Growers' Institute

HELD IN

COACHELLA VALLEY

CALIFORNIA

APRIL 10, 1937

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Saturday, April 10, 1937

MORNING SESSION

Introductory Remarks by Professor Robert W. Hodgson, Chairman

IT is both an honor and a pleasure to be called upon to serve as chairman of the morning session of this Date Institute and one for which I am deeply appreciative. On the back of the cover page of the attractive program which has been distributed you will find a brief statement concerning the history of this activity, and your attention is directed to the fact that today's meeting comprises the Fourteenth Annual Date Institute. In that connection I am reminded that it was my privilege to be present at the first or organization meeting of this Institute. I am sure we will all agree that since that time much progress has been made in our understanding of the problems of date production and marketing. Indeed I think it is a fair statement to say that during the past quarter of a century the date industry of the Pacific Southwest has made more progress toward an understanding of its problems and their solution than has occurred elsewhere in all recorded history. And in my opinion this Institute has played an important part in this progress. Most assuredly its Proceedings, now eagerly awaited and studied in many foreign countries, comprise by far the most complete, authoritative and altogether useful body of literature on date culture and marketing available anywhere.

Since the period when this Institute was organized it has been my very great privilege to see something of date culture in other parts of the world—Egypt, French North Africa, Palestine and India—and I am happy to be able to report that in all these countries the truth of the general statements I have just made is freely admitted. Indeed in several of them organizations similar to and patterned after this Institute have been formed and are actively functioning. Among the most notable of these are the Annual Date Growers Congress held in Algeria and the Annual Schools for Date Growers held in the Punjab province of India. In this connection you will of course recall the ancient saying about imitation comprising the sincerest form of flattery.

But I must proceed with the program which your committee has arranged for this morning.

DATE CULTURE IN THE PUNJAB, INDIA

By Robert W. Hodgson, University of California, Los Angeles

Introductory

A RECENT leave of absence without salary, granted by the University to permit acceptance of commissions to conduct horticultural surveys in India and Egypt, provided the opportunity to see something of the date industries of those countries. Since the assignment in India was general in nature and the area under study, Patiala State, lies in the Punjab and adjoins the region in which commercial date culture is practiced, an investigation of the date industry of the Punjab was considered desirable and was conducted in November, 1936. Accordingly a trip was made to Lyallpur, the seat of the Punjab College of Agriculture, and to several of the canal colonies or settlements where dates are grown. Limitations of time prevented the making of a comprehensive or detailed study of the industry but with the aid and assistance of the Fruit Specialist and Assistant Fruit Specialist of the College, Sardar Lal Singh and Sardar Bal Singh Bajwa, to whom I am greatly indebted, it is believed that a fair idea of the industry was gained. The observations made in Egypt were incidental to a technical survey of the citrus industry and were so fragmentary and detached that they are not considered worthy of recording.

The Distribution of Date Palms in Western India

Our port of disembarkation was Bombay and there we took the night mail train to the north, the terminus of which is Peshawar, in the mouth of the Khyber Pass, and the route of which lies mainly in the Rajputana and the Punjab regions. On awakening the next morning we were already in the area where the wild date palm and its near relative, the Indian palm, Phoenix sylvestris, abound. From that point on to our destination, the little city of Kalka, at the base of the Himalayan foothills, we were rarely out of sight of palms of these two species. Indeed, from these observations and subsequent travels it appears that the date palm grows wild in India over a very large area in the Rajputana and Punjab, and doubtless elsewhere. The total number must extend into the millions. The most surprising thing, however, was the very evident lower degree of utilization of these wild palms to that which exists in other date growing regions of the world. Indeed in many localities no use whatever seemed to be made of them and they appeared to be regarded as a nuisance.

Zone of Commercial Date Culture

Commercial date culture in India, however, is confined to the Western portion of the Punjab, from Dehra Ghazi Khan and Muzzaffargarh, near the mouth of the Indus River, to the canal colonies of Multan, Montgomery and Lyallpur extending to the east toword Lahore, the capital of the province. The older and at present most important areas are centered around Dehra Ghazi Khan, Muzzaffargarh and Multan, where more than two million female palms have been enumerated. Including the other and newer districts there are certainly more than three million bearing palms in the western Punjab.

By far the greater part of these palms are of seedling sorts or native varities, however, and produce fruit of inferior quality which commands a low price and is used locally. So far as could be determined the zone of potential commercial date culture is much larger than that now developed; indeed, it would appear that extension to the east and southeast would permit of increasing it severalfold.

Climatic Conditions

Temperature comparisons and calculations indicate that a considerable portion of the plains of the Punjab has sufficient heat for the ripening of dates, even the varieties of high heat requirement, and this is confirmed by the behavior of the principal Mesopotamian varieties, which mature in the months of July and August. The principal climatic hazard and that which limits the extension of the industry eastward up the plains of the Punjab is summer rainfall. For the climate is of the desert semi-tropical type in which the rainfall occurs during the summer monsoon period, roughly June 15 to September 15, and the rainfall gradient increases gradually with elevation as the Himalyan foothills are approached to the east. It was surprising to learn that the rainfall in the date-growing areas ranges from eight to fifteen inches. Desert sandstorms during the ripening season comprise another climatic hazard which sometimes interferes with harvesting and curing. The critical season of the year is therefore the period when the dates are ripening, during which there may be injury and loss from rain or sandstorms. While winter temperatures occasionally fall below freezing the success of tropical guavas, mangoes and bananas indicates the mildness of the winter weather. Excellent plantings of these and other tender subtropicals or hardy tropicals were seen growing side by side with or as interplants in date gardens at Lyallpur.

The Modern Date Industry of the Punjab

Milne is credited with being the father of the modern date industry of the Punjab and his book* remains a classic on the subject. Through his efforts the principal Mesopotamian varieties were introduced some 35 or 40 years ago and were shown to be adapted to the climatic conditions. The most important of these at the present time is Halawi though Khadrawi, Sayer, Zahidi and Zairi are also grown. The work he began, and conducted for years, is now ably carried forward by the Horticultural Section of the Punjab College of Agriculture. The two specialists working on date problems, whose names are given above, are both graduates of the College of Agriculture, University of California, and it is a pleasure indeed to be able to report that the work they are doing is, in my opinion, of a high order and most helpful to the industry, which continues to grow as rapidly as the supply of offshoots permits. Indeed the demand for offshoots was reported as regularly exceeding the supply. The standard price set by the Government, which supervises their cutting and supplies a considerable number, was said to be 1½ rupees (56 cents).

From the information provided, a good palm will bear 200 pounds of fruit and yields in excess of 300 pounds have been recorded. The Mesopotamian varieties command a price of four to six times that of local sorts and the demand exceeds the supply.

Experimental work of the past decade has been concerned mainly with improvements in propagation, and harvesting and curing methods. The use of large offshoots, weighing from 50 to 80 pounds, was formerly considered to be necessary and September was regarded as the best planting month. Extensive experiments, involving observations on approximately 4,000 offshoots, have demonstrated that much time and labor can be saved and equally good results obtained from the use of small offshoots, weighing not over 10 pounds. It has also been shown that planting in February gives better results than fall planting.

Fear of damage and loss from rain or sandstorms during picking and the sun-curing operations afterward has provided a strong incentive for improved methods of handling and curing the crop, and important and valuable progress has been made in that direction in recent years. The first important advance was the discovery that dipping the fruit in boiling lye, 1 per cent strength, for one minute cuts the usual sun-curing time of 6 to 7 days in half and gives a cleaner, better colored, less sticky and more uniform product. It was then learned that when applied to bunch picked fruit in the dokha stage (tips of the fruit still firm) this treatment resulted in a satisfactory product, fully as good as the sun-cured fruit picked in the dungh stage (tips of the fruit beginning to soften). This advance has stimulated the adoption of the practice of bunch picking and has materially reduced the hazards of loss and improved the quality and uniformity of the product.

Experiments have also been conducted with artificial heat maturation, at 125° to 130° F., and with very satisfactory results.

I had the pleasure of inspecting and sampling several of the packs and they were creditable indeed.

It is not expected that the industry will reach the point where fruit will be available for export for years to come, if ever, but there appears to be an adequate market at home for a vastly increased production. Costs of production are unquestionably low and the future of the industry appears to be promising.

*The Date Palm and Its Cultivation in the Punjab. D. Milne, Economic Botanist for Punjab Provinice. Calcutta. About 1910.

The Spread of Decline Disease In Date Palms[1]

By Donald E. Bliss, Assistant Plant Pathologist, University of California Citrus Experiment Station, Riverside, California

SINCE 1921, when symptoms of decline disease were first observed in a single date palm, the number of affected palms has increased to approximately 800. Although no systematic survey has been made, the disease is now known in 21 date gardens in Coachella Valley and in one experimental planting at Riverside. It is not supposed that the present condition can be traced back to any one infestation in this country, since the disease appeared in at least four locations at about the same time.

(1) Paper No. 375, University of California Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside, California.

The purpose of this paper is to record certain observations regarding the spread of decline disease and to discuss possible means of control by halting its spread in established areas and by preventing its transmission to locations which are disease-free. The nature of decline disease and the food habits of its casual organism will be described first to form a background of information which is prerequisite to an understanding of the problem at hand.

There is evidence (2) that decline disease of date palms is caused by a soil-inhabiting fungus which belongs to the genus Omphalia. All underground parts of the palm may be attacked by the fungus, but the principal injury results from the destruction of roots. The initial stages of root decay cause little, if any, effect on the aboveground portions of the palm. As the extent of injury increases, however, the familiar secondary symptoms (3) appear, such as the premature death of leaves, retardation in terminal growth, and reduction in size of leaves and fruitstalks. The fruit from severely affected palms is nearly worthless.

Pure cultures of Omphalia sp. have been obtained from diseased palms in 14 different gardens. The colonies of fungus mycelium have been propagated on sterile nutrient media (agar agar, wheat bran, palm roots, etc.) since they were first separated from the diseased tissue of date palm and purified by the elimination of contaminating micro-organisms. The mycelium of Omphalia sp., when grown on solid media, resembles superficially a mass of cotton or glass wool. Microscopic examination of this mycelium reveals long, branched filaments (called "hyphae") which are tubular, colorless, and contain cross-walls. There is living substance (protoplasm) within the filaments which, in certain respects, is similar to the protoplasm of the cells of the date palm and other members of the plant kingdom. Under favorable environmental conditions, the hyphae grow by elongation and branching. The size, shape, and texture of the colony are influenced by numerous factors, such as the kind and amount of food, temperature, humidity, etc. A loose, cottony type of mycelium will develop if the air is moist. Under less humid conditions the fungus will sometimes form strands of tightly woven hyphae which are known technically as "rhizomorphs."

Omphalia sp. also produces small toadstools in which spores are formed. Laboratory studies indicate that the toadstools produced by the different strains are not all exactly alike but that they fall in two groups or species (4). Since the behavior of the two species is similar so far as the subject of this paper is concerned, they will be treated together.

When Omphalia spp. are placed in soil about healthy date palms (5), the mycelium first becomes established in the dead portions of the outer leaf bases. Rhizomorphic strands then penetrate to inner layers of leaves and grow along root surfaces where mats of mycelium become closely attached to the epidermis. Underlying cells are killed, their walls darken, and often collapse, before fungus invasion begins. In leaf tissues the starch grains disappear from cells at the margin of the advancing lesion. Apparently the fungus enters wound-free tissues, penetrating cell walls and filling all cavities, including the vascular elements, with closely woven masses of hyphae. Although small at first, lesions may enlarge gradually until entire sections of roots and leaf bases are killed.

Omphalia spp. are facultative parasites; that is, they are not limited in food requirements to the living tissues of date palm. They grow saprophytically on the common sorts of laboratory media, on wood, dung, and other organic matter. Two common desert plants, the creosote bush (Larrea tridentata) and the California incense plant (Encelia farinosa), showed little or no sign of injury after inoculation, but the fungus lived saprophytically for a period of nine months in the dead outer bark of the roots.

The longevity of the mycelium is remarkable even when subjected to conditions which are unfavorable to growth. A block of wood and roots from the trunk of a diseased palm were air-dried in the laboratory. A viable culture of Omphalia sp. was obtained from them after two years. In another experiment, segments of date palm roots were inoculated with the fungus and buried in potting soil which was maintained in the greenhouse in moist condition. Omphalia sp. was recovered two years later from these roots, although by that time the root tissue was nearly decomposed.

It is probable that the spores of Omphalia spp. play only a minor role in spreading decline disease. Thus far the writer has seen only one group of toadstools in the open. These specimens developed from the base of a Saidy offshoot after a heavy rainstorm in midsummer. Many toadstools have been produced, however, under artificial conditions in the greenhouse. The most favorable environment for the development of toadstools seems to be one in which soil and air temperatures are maintained between 80° and 85° F. and the relative humidity of the air is held between 92 and 98 per cent. The toadstools arise from the dead, outer leaf bases of diseased palms at points near the soil level. The apparent scarcity of these sporophores in diseased date gardens indicates that environmental conditions are seldom favorable to their development.

The spread of decline disease appears to be due principally to the growth and distribution of Omphalia spp. in the mycelial stage. This mycelium is so inconspicuous sometimes that it is difficult to demonstrate its presence in a diseased palm. This applies especially to mature palms, long affected by the malady, in which various nonpathogenic organisms have invaded the necrotic tissue. In other cases it is not difficult to isolate the pathogen where it is still active in forming young lesions.

Two methods have been employed in the diagnosis of decline disease. The first involves isolation and inoculation techniques, together with microscopic examination. This laboratory method requires time and skill but it is considered relatively accurate. Diagnosis by the second method is based on the recognition of disease symptoms in the field. It has been employed extensively in making surveys and, although rapid, it is thought to be less accurate than the laboratory method.

Spread of the Disease from a Focus of Infection

The exact method by which the mycelium of Omphalia spp. spreads from one palm to another is not known. Rhizomorphs have been observed on the surface of roots but there is as yet no proof that these grow from one palm to another. No satisfactory method has been found for the distinction of free-living my-

(2) Bliss, Donald E. 1934a. Investigations on the cause of decline disease in date palms. Date Growers' Instit. Ann. Rept. 11:4-6.

(3) Bliss, Donald E. 1933. Symptoms of decline disease. Date Growers' Instit. Ann. Rept. 10:10.

(4) Technical descriptions of these species are being prepared for publication in another place.

(5) Bliss, Donald E. 1934b. The parasitic action of Omphalia sp. on tissues of the date palm. Phytopath. 24:1143. (Abstr.)

celium in soil where many kinds of micro-organisms exist. There can be little doubt, however, that the fungus spreads from tree to tree.

Fawcett and Klotz (6) traced the enlargement of a decline disease area which began in 1921 with one palm and enlarged gradually to include 31 palms in 1928. A similar instance was observed in another place which will be designated here as Garden No. 1. Sixty-one Deglet Noor offshoots, which are said to have come from Algeria in 1913, were planted in four rows. Adjoining them on both sides were date palms of the following varieties: Kustawy, Zahidi, Khalasa, Tafazwin, Deglet Beida, and Halawy. The first palm to show decline was one of the Deglet Noor variety standing near the center of the planting. From it, the disease seemed to spread in ever-widening circles, affecting all palms of the Deglet Noor variety but producing no symptoms of decline in palms of the other varieties mentioned above. Between 1922 and 1935, decline disease spread from 1 to 60 palms and finally prompted the owners of the garden to destroy this entire planting of the Deglet Noor variety.

Most of the decline disease areas have increased gradually in extent since the first survey records were made. However, an area in Garden No. 2 has remained static since 1931, judging from the number of palms with visible symptoms. That the condition is diagnosed correctly is based on the isolation from one of the palms of a strain of Omphalia which resembled those from other decline areas in appearance and pathogenicity.

Perhaps the most accurate information regarding the spread of Omphalia in a decline-disease area is that obtained in Garden No. 3. Visible symptoms of decline were evident in five palms of the Deglet Noor variety in September, 1933, and roots from three of these palms yielded cultures of Omphalia sp. By July, 1935, the diseased area had enlarged to include additional palms. Omphalia sp. was obtained from four of these. In March, 1936, root specimens were taken from 21 palms that surrounded the area of known infestation. Laboratory tests detected Omphalia sp. in nine of the 21 palms. Seven of the nine affected palms bore no outward symptoms of decline when the root specimens were obtained. Thus, a diseased area composed of 13 visibly affected palms was actually found to include 20 palms when the laboratory method of diagnosis was applied. This indicates that the first phase of decline disease is confined to the roots and that the injury to these vital organs may be well advanced before the effect can be detected in the above-ground parts of the palm.

(6) Fawcett, H. S., and L. J. Klotz. 1932. Diseases of the date palm, Phoenix dactylifera. California Agr. Exp. Sta. Bul. 522:1-47.

Creation of New Foci of Infection

One of the most alarming features of the situation regarding decline disease is that new centers of infection are being discovered each year. The occurrence of the disease may be explained in one of two ways: either Omphalia spp. are indigenous to Coachella Valley or they were introduced. The disease has not been reported from any other country of the world, although this lack of evidence does not preclude the possibility of a more widespread occurrence.

Evidence on the transmission of decline disease by means of offshoots was presented by Bliss (2) in 1934. Omphalia sp. was isolated from offshoots which were taken directly from diseased palms. In some cases there were numerous lesions in the basal parts of the offshoots which were thought to have originated by spread of the infection from the parent palm.

The contamination of offshoots by diseased mother palms offers an explanation for certain experimental results obtained in Garden No 4. In 1928, a transplanting experiment was started, using 22 offshoots from diseased Deglet Noor palms and 34 offshoots from healthy trees of the same block. The two lots of offshoots were planted in adjoining rows and at some distance from the affected area. Although these offshoots are said to have been equal in size at the beginning of the experiment, they did not grow at the same rate. After six years the average volume in the tops of those palms derived from healthy parents was six times greater than it was in the palms whose parents were diseased. Furthermore, the symptoms of decline had appeared in nearly all members of the latter group, while those of the first group were apparently healthy. Examination of the roots indicated the presence of Omphalia sp. only in palms which came from diseased parents.

Offshoots for the original planting in Garden No. 4 were among those imported from the Old World in 1914. Several hundred offshoots were taken from this garden during 1925 and 1926. Some of these were used to plant a new block of palms in garden No. 4, while the others were sold to two date growers of Coachella Valley. In 1927, symptoms of decline were first discovered in two palms of the parent garden. This area was surveyed thereafter at yearly intervals. A gradual spread of the disease was noted until in 1935 there were 47 affected palms. In Garden No. 4, four of the palms of the 1925 planting had developed symptoms of decline by 1934. Laboratory tests substantiated these diagnoses in all cases. The two other plantings made in 1925 and 1926, respectively, developed no signs of decline disease.

A common practice among the date growers of Coachella Valley is that of planting new blocks of palms with offshoots which are taken from older sections of their gardens. In certain cases where decline disease occurred among the parent trees prior to the removal of offshoots, there is circumstantial evidence that the growers inadvertently spread the disease to these new blocks by the use of infected planting stock. Such was the case in Garden No. 1. Three new foci of infection appeared in a group of young palms which originated as offshoots from an older planting where decline was known.

There is a serious situation in Garden No. 5 because of the widespread occurrence of decline disease in the original Deglet Noor planting and also in two younger blocks of palms which were propagated in 1923 and 1928, respectively, as offshoots from the older trees. Decline disease was apparently well established in the original planting prior to 1923. Records taken by the owner indicate that in May, 1928, 68 out of a total of 217 palms, or 31 per cent, were affected. According to surveys made by the writer, 32 per cent of the palms were diseased in 1931 and 55 per cent in 1936. In one of the young blocks which was planted in 1923, the symptoms of decline appeared about 1930. Spread of the disease in this block was noted at yearly intervals as follows: There were 8 affected palms in 1931, 12 in 1932, 21 in 1933, 33 in 1934, 41 in 1935, and 58 in 1936. Since the disease appeared almost simultaneously in several parts of this block, it seems likely that a number of foci of infection had been established.

The palms in Garden No. 6 were taken as offshoots from a nursery at Yuma, Arizona, and planted near the lower end of Coachella Valley. Because of poor growing conditions the palms were transplanted about 1927

to their present location near Indio. In 1932 decline disease was evident in palms at several locations in the planting. Although evidence is lacking in regard to the origin of the disease, it may be conjectured that at one time the affected palms were situated in a group and that all of them contracted decline disease. The arrangement of the palms was changed during the transplanting operation, thus mixing diseased palms among healthy ones and creating several new foci of infection.

Offshoots from Garden No. 7 were sold for planting Garden No. 8. Decline is now manifest in both gardens, and it is believed that the disease was transmitted on the planting stock.

In addition to diseased palms, the detached portions of such trees are also considered to be potential carriers of Omphalia spp. This danger was shown in Garden No. 9 after the removal of a large diseased palm. Small seedling date palms, which had germinated from the pits of fallen fruits, developed typical lesions where they touched diseased root segments of the large palm. Likewise, a detached leaf base which was dug from soil of another decline-disease area was found to be completely filled with the mycelium of Omphalia sp. Since Omphalia-infested wheat bran is regularly used as inoculum in artificial inoculation experiments, it seems possible that similarly infested material would also transmit the disease under field conditions.

Discussion

The foregoing observations throw some light on the epidemiology of decline disease. In general, parasitic plant diseases depend (1) on the presence of certain pathogenic organisms, (2) on the availability of susceptible hosts, (3) on proper agents of transmission, (4) on favorable environmental conditions, and (5) on a period of incubation during which characteristic disease symptoms appear. The amount of injury depends both on the relative distribution and on the concentration of parasites and hosts. Also, it is influenced largely by environmental conditions and the length of time during which the disease is active.

In the case of decline disease, two species of Omphalia are believed to be the specific causal organisms. Either one or the other has been found in 14 different date gardens. The Deglet Noor variety of date palm is very susceptible to the disease and now represents approximately 90 per cent of the 3,200 acres of commercial plantings in Coachella Valley. The two species of Omphalia are supposed to spread from centers of infection by mycelial growth through the soil; they are transmitted on diseased palms and their offshoots. The environmental conditions which favor the commercial production of dates are apparently favorable also to the development of decline disease. Although poorly defined as yet, five years may be considered tentatively as the amount of time after inoculation which is necessary for the development of characteristic disease symptoms.

Considering the date industry of Coachella Valley as a whole, decline disease has caused thus far only slight losses. The affected palms constitute about 0.5 per cent of the total acreage reported (7) in Riverside County. However, in certain gardens where this trouble has been active for a period of ten years or more, injury from decline has increased so rapidly in recent times as to assume a role of major importance. While it is impossible to predict what effect decline may have on the future of the date industry, experience indicates that infested areas will increase both in size and number unless something is done to check this disease.

It is possible that decline disease might be controlled by the eradication of the causal organisms or by the use of disease-resistant hosts. If the transmission and spread of the disease cease, decline no longer would be a menace. Bliss (8) has suggested two methods for the control of decline disease which bear directly on the limitation of its spread. These are, first, the eradication of Omphalia spp. by means of soil disinfection; and, second, the use of healthy offshoots for planting.

No means has been found for curing palms with decline disease. Experience has shown that the removal of sick palms will usually not prevent further enlargement of the affected area. Healthy offshoots have become diseased (2) within five years after being planted in the holes from which diseased palms were removed.

Control by means of soil disinfection involves the destruction of affected palms, the disinfection process, and replacement with healthy offshoots. This method is obviously worthless unless the fungus is eradicated completely. It is rather expensive and it does not prevent reinfestation. However, the method is believed to be effective and it is especially well adapted for use in stamping out small areras of infestation.

In new plantings of date palms, freedom from decline disease depends both on the use of healthy offshoots and on the absence of Omphalia spp. from the soil. Until more facts are known regarding the origin of decline disease, it may be assumed that this malady will not appear unless one or both of the causal organisms are introduced artificially. It is probable that most of the available planting stock is free from Omphalia spp. However, it is difficult to judge with certainty whether or not a certain palm is free from contamination. The most painstaking laboratory examination might fail to detect minute quantities of the fungus. For practical purposes, offshoots suitable for use may be obtained from healthy appearing palms whch are well removed from decline-diseased areas.

It is not within the province of this paper to suggest the enactment of legal regulations, but it is the writer's opinion that concerted action among the date growers is necessary in order to check the spread of decline disease.

Summary

Decline disease, which was first observed in 1921, has appeared in 22 date gardens, affecting approximately 800 palms. The cause and nature of the decline disease are reviewed. A comparison of the toadstools produced by different strains of the causal organism indicate that two species of Omphalia are involved. These species are capable of existing indefinitely as saprophytes on various kinds of organic matter and possess remarkable longevity under conditions which are unfavorable to growth.

The spores of Omphalia spp. are probably unimportant in spreading decline disease. The mycelium apparently grows through the soil from tree to tree and it is carried on diseased palms and their offshoots. Several instances are described in which decline disease has spread outward from one focus of infection until many or all of the palms of the susceptible Deglet Noor variety have become affected. The presence of Omphalia sp. was demonstrated in

(7) Blair, R. E., W. R. Schreiber, and C. N. Guellow. 1937. Summary of California fruit and nut plantings. Acreage survey of 1936. U. S. Dept. Agr. coop. with California Dept. Agr. Calif. Coop. Crop Reptg. Serv., Apr. 1937, 13 pp.

(8) Bliss, Donald E. 1935. Soil disinfection as a means of combating decline disease in date palms. Date Growers' Instit. Ann. Rept. 12:13-16.

roots of apparently healthy palms which stood on the margin of a decline area. This indicates that the first phase of the malady is confined to the roots.

The results of a tansplanting experiment are reviewed to show that decline disease is carried on offshoots from diseased palms. The history of several date gardens is given to illustrate the origin of new centers of infection. Detached portions of diseased palms are considered to be potential carriers of Omphalia spp.

Five factors are named and discussed in relation to the epidemiology of decline disease. The eradication of Omphalia spp. by means of soil disinfection and the use of healthy offshoots for planting are suggested as control methods to limit the spread of decline disease.

Floor Discussion Following Talk on Decline Disease

Mr. Barger: Is the evidence of Omphalia found at any particular level in the soil?

Mr. Bliss: The concentration of Omphalia sp. is greatest about the base of the trunk in the upper two feet of soil, although it is found to a depth of four feet.

Mr. Cavanaugh: Is there any relationship between the spread of decline and the flow of water in irrigating?

Mr. Bliss: I have not noticed any.

Mr. Kinnison: Are any other varieties than seedlings affected?

Mr. Bliss: I know of one instance in which a Saidy offshoot was affected.

Crosscuts In the Fruitstalks of Date Palms[1]

By Donald E. Bliss, Assistant Plant Pathologist, University of California Citrus Experiment Station, Riverside, California

IN June, 1932, the attention of the writer was called to a breaking or rotting off of fruitstalks of the date palm. Examination of several specimens of fruitstalks from the Imperial and Coachella valleys revealed fractures of various sizes. These extended part or all of the way across the fruitstalk and were situated relatively near the point of attachment of the spadix to the trunk. The tissues surrounding these breaks were commonly infested with fungi and bacteria. However, in some cases the break was apparently free from decay and, from external appearances, seemed to originate from mechanical injuries. Certain information here recorded was obtained regarding the nature of this disease.

Fawcett and Klotz (2) describe and illustrate V-shaped notches and crosscuts in the leaf bases of date palms. They attribute these types of fracture to mechanical injury which occurred at an early stage in the development of the rapidly expanding, tender fronds near the terminal bud of the tree. Since the breaking of fruitstalks is similar in certain respects to that found in leaf bases, the malady which furnishes the subject of this paper will be called the crosscut disease of fruitstalks.

Generally speaking, the crosscut disease is of little economic importance in the Coachella and Imperial valleys of California. In some varieties of date palm, such as the Deglet Noor and Zahidi, its occurrence is so rare that it is considered a curiosity. The disease is most common in the Sayer variety and is found occasionally in the Dayri, Maktoom, Khadrawy, and Halawy varieties. Brown and Butler (3) report the occurrence of an inflorescent blight which affects Iteema, Maktoom, Sayer, Khir, and seedling date palms in Arizona. It is of interest to note that in both the Arizona and the California diseases two processes are involved, namely, the fracture and decay of the fruitstalk. Information from another source (4) indicates that in 'Iraq the Sayer variety is also especially affected by a disease of similar character.

The experience of date growers indicates that the crosscut disease is somewhat intermittent in its appearance. In 1934 approximately 1,000 fruit bunches were lost because of this trouble in a garden near Thermal. This amount of damage is said to be much greater than that during any previous year. Subsequent to 1934 only slight losses have been experienced.

In a date garden near Oasis the crosscut disease appeared in three Sayer palms 10 to 15 years of age. The trouble became progressively worse and has caused repeated losses of fruit during the past 7 years.

Specimens of the crosscut disease were received in April, 1936, from Mr. H. W. Gray, who obtained them from a seedling date palm near El Centro. Although this was the first instance observed by Mr. Gray in the Imperial Valley, the writer observed it there in 1932.

Symptoms

The crosscut disease is characterized by the wilting and subsequert death of the fruitstalk. When the stalk is severely fractured, the characteristic symptoms develop rapidly. When the stalk is only partially severed, wilting and necrosis appear more gradually. In such cases the injury begins at the distal end of the fruit strands and progresses backward toward the region of the fracture. The injury has been observed mostly during the period from March to June, in which period the fruitstalks are elongating most rapidly and the date fruits come to resemble green peas in size and color.

Information regarding the early stages of the crosscut disease was obtained in April, 1935, when 8 pollinated inflorescences were dissected from a large affected date palm of the Sayer variety. Beginning at the upper extremity of the trunk, the leaves and fiber were removed from one side of the palm in such a manner that the spathes were completely exposed to view before they were cut at the point of attachment. Five healthy-appearing inflorescences were dissected from the palm before 3 diseased ones were obtained. A brief description of the affected inflorescences follows:

In inflorescence No. 1 there was a distinct swelling, attended by darkening and cracks, on both sides of the spathe at a distance of 25 cm. (about 10 in.) from the point of at-

(1) Paper No. 377, University of California Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside, California.

(2) Fawcett, H. S., and L. J. Klotz. 1932. Diseases of the date palm, Phoenix dactylifera. California Agr. Exp. Sta. Bul. 522:1-47.

(3) Brown, J. G., and Karl D. Butler. 1936. Inflorescence blight of the date palm. Phytopath. 26:88. (Abs.)

(4) Unpublished conversation between Beg Abdul-Rassacq of Basra, 'Iraq, and Mr. Robbins Russel, Thermal, California.

tachment. Figure 1C illustrates the appearance of the spathe at the point of injury. Figure 1A shows that when the spathe was opened, a complete break was found in the fruitstalk. This fracture was situated at about the same level as the swelling previously noticed in the spathe. The fruit strands and the exposed portion of the stalk were dead. A portion of the fruitstalk above the break, but protected by the spathe, had retained its yellow color and appeared in a fairly fresh condition. It was noticed, however, that this portion of the stalk was more wilted and of a darker color than was the part below the fracture. Bacterial slime covered the fractured surfaces of the fruitstalk and also exuded from brown, necrotic lesions on the inner surfaces of the spathe.

Inflorescence No. 2 also contained a complete fracture of the fruitstalk. This crosscut was situated 43 cm. (about 17 in.) from the base of the fruitstalk. The broken ends were very regular in outline and at right angles to the main axis of the spadix. The tissue of the fruitstalk was darkened for a distance of 1 to 2 cm. (0.4 to 0.8 in.) on either side of the break, and bacterial slime covered the surface of the discolored areas. The disconnected portion of the spadix was dead at the distal end and was more or less wilted and shrunken near the point of fracture.

Inflorescence No. 3 was similar to those already described, except that more decay had developed in the fruitstalk on both sides of the crosscut. In addition to bacteria, there was a Fusarium-like mold and a number of small, white, insect larvae of undetermined origin. The unattached part of the fruitstalk was shrunken.

Inflorescence No. 4 appeared to be normal before it was taken from the palm. Although the stalk was partially fractured at two places, as shown in Figure 1D, there was as yet no wilting or necrosis in the fruit strands. One break extended about two-fifths of the distance across the stalk, while the other fracture involved only the central portion of the stalk and did not extend laterally to either edge. In other words, the last-mentioned crosscut gave the appearance of an irregularly shaped hole when the fruitstalk was viewed from the broad side.

Up to this time it was possible to account for all the crosscuts which had been examined on the basis of mechanical injury. It was more difficult to explain the origin of the fracture which resembled an irregularly shaped hole in the middle of the stalk. This problem led to an examination of the inside of this fruitstalk. Figure 2A illustrates an interior view of the stalk after it was split longitudinally. It was found that the above-mentioned hole led to a saucer-shaped cavity within the stalk. A similar cavity, but one which did not reach the surface, was situated about 1 cm. (0.4 in.) above the first. The tissue surrounding these cavities was blackened, necrotic, and somewhat shrunken, owing to desiccation.

The first-mentioned crosscut in inflorescence No. 4 was also examined by splitting open that portion of the fruitstalk (Fig. 2A). There was discovered a series of 4 saucer-shaped cavities, one above the other, and situated at intervals of 1 to 3 cm. (0.4 to 1.2 in.) These flattened

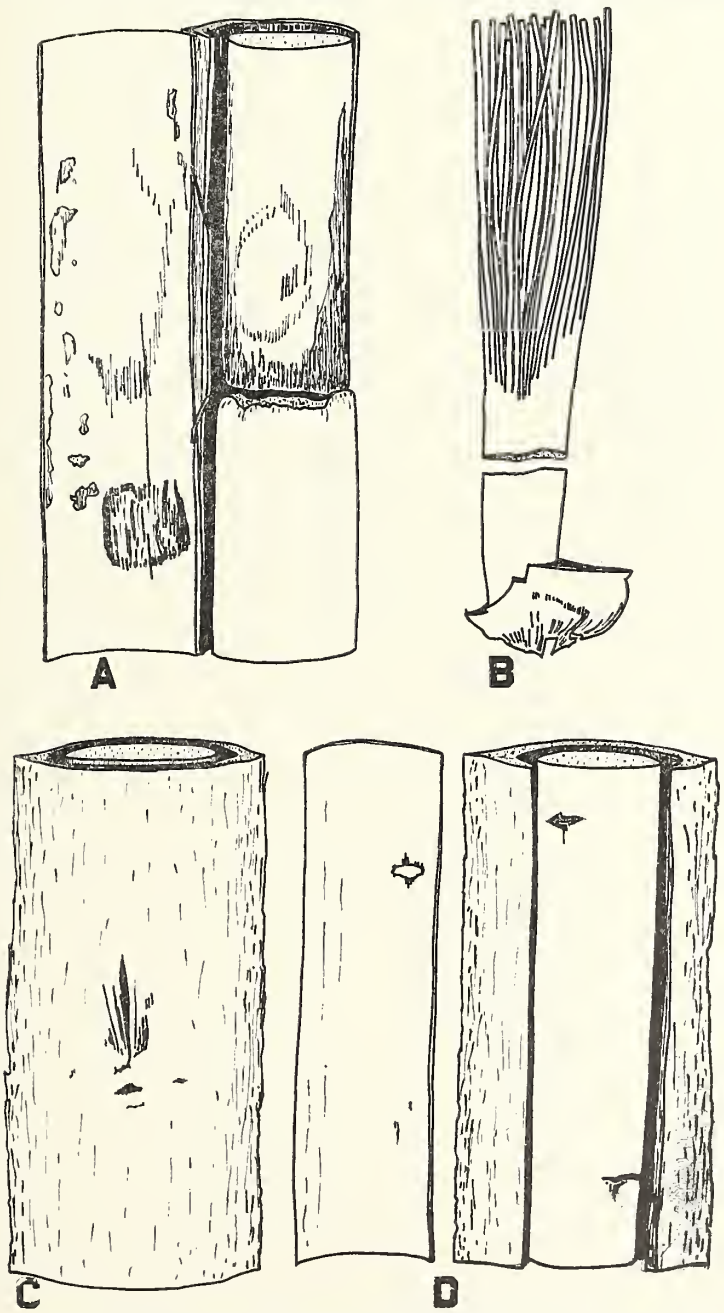

Figure 1.—Crosscut disease of fruitstalks in the Sayer variety of date palm: A, portions of an inflorescence showing a complete fracture of the fruitstalk and discoloration and cracks on the inner surface of the spathe. XO.54. B, a young, healthy spadix showing the effect of artificial breaking. XO.33. C, surface view of the same spathe as that shown in A. XO.46. D, portion of an inflorescence with a part of the spathe removed to show two partial fractures in the fruitstalk. XO.37.

cavities were oriented transversely to the long axis of the spadix. Only the largest cavity opened on the surface of the fruitstalk, while the others were hidden from view. Here also the tissue connecting the cavities was darkened. A thin, irregularly shaped passage extended from one to the other. The inner surfaces of the largest cavity were covered with Fusarium sp., but it was noticed that the small cavity farthest from the opening was free from similar contamination.

The idea then developed that crosscuts might originate from cavities within the fruitstalk. This led to a closer examination of certain small, brown streaks in the tissue which were encountered frequently when both healthy-appearing and diseased fruitstalks were split longitudinally. Three streaks of this kind are indicated in Figure 2A. Microscopic examination of these brown streaks, which measured 1 to 20 mm. in length and 1 mm. in width (0.04 to 0.8 in. in length and 0.04 in. in width) revealed a disorganized condition among the cells, the formation of small cavities and splits, and discoloration or necrosis of the surrounding tissue. Figue 2B shows a highly magnified longitudinal section through a brown streak. In this case there were remnants of cells which had broken down and other cells which seemed to be overgrown and arranged in unnatural positions.

Etiology

A number of isolations were made from the Sayer fruitstalks described above. Bacteria and Fusarium sp. were obtained from tissue surrounding the open crosscuts in inflorescences 1, 2, 3, and 4. However, there was sterile tissue surrounding several small, saucer-shaped cavities, such as those described in inflorescence No. 4. Also, the small, brown streaks containing microscopic cavities were apparently free from microorganisms.

A culture of Fusarium sp., which was isolated from a fruitstalk affected with the crosscut disease, was pathogenic when inserted through artificial wounds in the leaf bases of a date palm. Several other cultures of Fusarium sp. taken from date palm leaves and inflorescences also showed a mild form of pathogenicity in wounded leaf tissue. No inoculations were made into fruitstalks.

Discussion

Several theories have been advanced regarding the cause of crosscuts in fruitstalks. Among these are, first, mechanical injury due to the tight wrapping of the fiber; second, mechanical injury caused by the swaying action of wind on the palm, and third, fungus attack by two species of Fusarium. The latter explanation was advanced by Brown and Butler (3) to account for the inflorescence blight of date palms in Arizona. The proof of this theory is based on the production of rapid decay in healthy date fruitstalks in which pure cultures of these organisms had been inoculated and on the reisolation of similar cultures from the affected tissue. It is presumed that these inoculations involved the artificial wounding of the fruitstalks.

Considering the evidence at hand, there is no reason to doubt the ability of certain Fusarium spp. to cause decay in young fruitstalks of date palm. However, there is no evidence that these fungi will initiate such

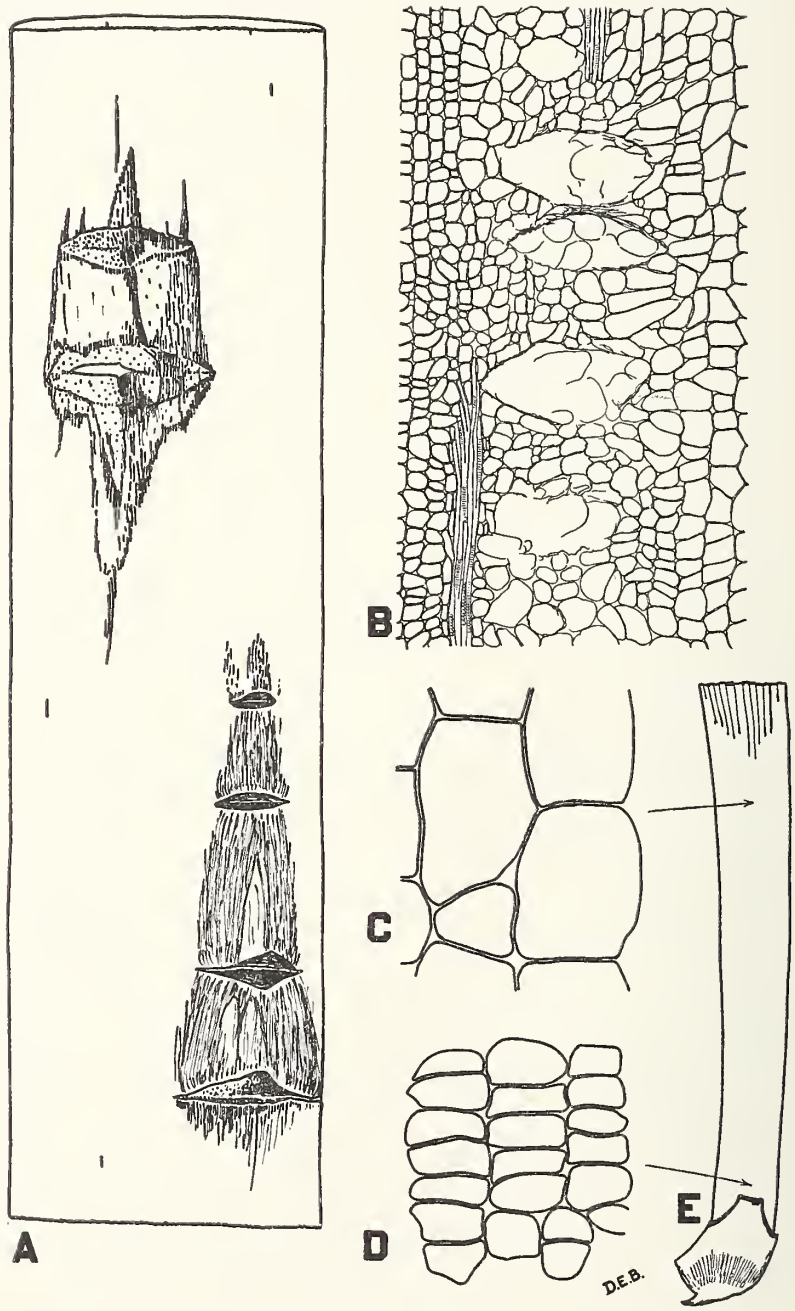

Figure 2.—Crosscut disease of fruitstalks: A, longitudinal section of the same fruitstalk that was illustrated in Figure 1D, showing internal, saucer-shaped cavities and small, brown streaks. X0.83. B, longitudinal section of small, brown streak showing cavities and disorganized condition of cells. X38.5. C, parenchyma cells (in longitudinal section) taken about 60 cm. from base of fruitstalk. X273. D, parenchyma cells (in longitudinal section) taken within 12 cm. of the base of the fruitstalk. X273. E, spadix with arrows indicating the relative locations of tissues illustrated in C and D. X0.22.

fractures as have been observed in connection with the crosscut disease. Where Fusarium spp. enter a small crosscut or wound on one side of the stalk, it is possible that decay will spread to the other side, thus rotting a portion of the spadix and blighting the inflorescence. This type of decay may be involved as one factor in the crosscut disease but it is believed to be of secondary importance.

The discovery of sterile fractures within the fruitstalks placed a new interpretation on previously observed facts. It suggested that crosscuts were in some way associated with structural weaknesses in the tissue and that microorganisms did not enter the picture until after the fractures had reached the surface.

Some properties of young date palm fruitstalks are illustrated in Figures 1 and 2. A healthy spadix, shown in Figure 1B, was broken artificially at a point 7 cm. (2.8 in.) above its base. The tissue was found to be tender and easily fractured, the plane of breakage being nearly vertical to the major axis of the fruitstalk.

Microscopic examination of the parenchyma cells of a healthy fruitstalk (Fig. 2E) showed that those cells (Fig. 2D) within 12 cm. (4.7 in.) of the base were more or less brick-shaped and packed tightly together. These cells were in a condition of active cell division and they contained many starch grains. Figure 2C shows other parenchyma cells equally magnified which were sectioned at a point about 60 cm. (23.6 in.) from the base of the fruitstalk. These cells were probably similar at one time to those in Figure 2D but their size indicated that a ten-fold enlargement had occurred. Cell division had ceased and only a little starch was visible in the tissues.

Plant growth depends mostly upon the formation and enlargement of cells. Haas and Bliss (5) showed that in the date fruit the region of most rapid growth is that enclosed by the calyx and that a secondary growth results from the enlargement of the cells. A similar type of growth is thought to occur in the fruitstalks; that is, primary growth involving cell division takes place near the base of the spadix, while secondary growth results from cell enlargement.

It is commonly observed in California that the spadices of date palm elongate rapidly from the time of their emergence in February or March until June or July when they are fully grown. The fruitstalk shown in Figure 1B measured 11 cm. (4.3 in.) in length on March 30, 1935. Judging from the growth of other fruitstalks it is possible that this one might have reached a length of 180 cm. (about 6 ft.) within a period of three months. Such an elongation would amount to an average increment of 1.8 cm. (0.7 in.) per day. Since it is believed that the regions of primary and secondary growth are situated relatively near the base of the fruitstalk, such elongation suggests a condition in which the cells of this region divide and enlarge very rapidly.

The disorganized appearance of the cells within the small brown streaks (Fig. 2B) furnishes a possible clue to the origin of crosscuts. While final decision must await further observations, the suggestion is advanced that the cavities result from inherent weakness and unequal mechanical strains in the tissue of the fruitstalk in the zone of most rapid growth. Nothing is known regarding the nature of this weakness, or is there any information which would lead to the correction of the trouble.

It would seem that the control of the microrganisms which have been associated with decayed tissue surrounding open crosscuts would not prevent the formation of sterile, internal fractures which are thought to be the incipient stages of the crosscuts.

It is said (4) that in commercial plantings of the Sayer variety a certain loss from crosscuts is anticipated each year and is provided for in the spring by retaining more fruit bunches than are expected to mature fruit. By this means an adequate harvest is secured in spite of the injury caused by the crosscut disease.

(5) Haas, A. R. C., and Donald E. Bliss. 1935. Growth and composition of Deglet Noor dates in relation to water injury. Hilgardia 9:295-344.

Significance of Salt In Coachella Valley Agriculture

By Frank M. Eaton, Physiologist, Division of Western Irrigation Agriculture, Bureau of Plant Industry, United States Department of Agriculture

THE notable quantities of salt naturally occurring in many Coachella Valley soils have from the initiation of the agriculture of this area been regarded as significant. Swingle (1) and Kearney (2) in their reports of 1904 and 1906 on date culture respectively in Tunisia and Algeria devoted special attention to salinity because they considered it one of the major adversities to be dealt with in the agricultural development of Salton Basin area. In the Soil Survey of 1903 (3) and again in the more recent one of 1928 (4) special emphasis has been placed on salinity in its relation to the agricultural potentialities of the Coachella Valley. The subject assigned for this talk is not accordingly very foreign to your thinking.

Irrigation waters, whether they are pumped from the ground or diverted from streams, always carry in solution measurable quantities of salt. As a consequence a potential salt problem exists wherever in arid regions waters are applied to the land to supplement the rainfall.

The intensity of salinity conditions in irrigated soils is dependent upon a number of factors among which there may be mentioned: (1) the quality of the irrigation water; (2) the permeability of the soils and their drainage conditions as these influence the movement of water and the leaching of salt residues from the rootzone; and (3) the manner and abundance of use of the water, since these factors also govern the effectiveness of salt removal. As a fourth consideration one should indicate that the relative proportions of the natural rainfall and irrigation water also have significance, insomuch as meth-

(1) Swingle, Walter T. 1904 The Date Palm and Its Utilization in the Southwestern States. Bureau of Plant Industry Bulletin No. 53. 155 pp. Illus.

(2) Kearney, Thomas H. 1906 Date Varieties and Date Culture in Tunis. Bureau of Plant Industry Bulletin No. 92. 110 pp. Illus.

(3) Holmes, J. G., and party. 1904 Soil Survey of the Indio Area. Field Operations of the Bureau of Soils. 1903. United States Department of Agriculture.

(4) Kocher, A. E., and Harper, W. G. 1928. Soil Survey. The Coachella Valley Area of California. United States Department of Agriculture.

ods of use and kinds of waters suitable in areas with 10 or 15 inches of rain and moderate evaporation conditions may be quite unsuited to locations with intense climatic conditions and a very low rainfall.

The salinity problem of the Coachella Valley is in a measure different from those in some other irrigated areas of the west in that here the general trend is apparently in the direction of improvement. That is not to say, however, that a reduction in salinity is everywhere taking place as rapidly as it might or that improvement is in progress in all of the cultivated lands. In some soils salinity conditions are virtually nonexistent whereas in others they are becoming more severe. There undoubtedly was more visible evidence of salinity in this valley when I first saw it twenty years ago than there is now.

Three circumstances have favored a general improvement in your salt situation: (1) The irrigation waters of the Coachella Valley with few exceptions contain comparatively little salt. (2) For the most part the supply of water has been adequate and for this reason the tendency has been to use it freely enough to promote leaching. (3) Opening the artesian basin by deep wells and the pumping of water has served to lower subsoil water tables and to reduce thereby the surface deposition of salt resulting from the evaporation of capillary water. This latter consideration recognizes leakages in the ceilings of the high pressure ground water strata as responsible for springs and for some of the high water tables that have existed within a few feet of the ground surface.

Effect of Salt on Plant Growth

Work which we have had in progress at the Rubidoux Laboratory during the past several years has pointed to the necessity of material modification of many of the older conclusions on the subject of salt injury to plants (5).

Plant appearances for example can only rarely be depended on as a criterion of salt injury. The growth of such plants as tomatoes, cotton, and alfalfa and in some cases citrus can be reduced by salt to 50 per cent of that of control plants without the development of any prominent symptoms. Other than for reduced growth as reflected by direct comparison with control plants, salt injured plants usually appear normal. Characteristics or abnormalities which permit of the recognition of injury or the diagnosis of injury in the field are for the most part lacking except in the more extreme cases. The general appearance of salt injured plants is not very unlike that of plants on infertile soil or plants which have not been adequately supplied with water. It is for this reason that the annual curtailment of production that results from excesses of salt in irrigated soils can not be appraised even approximately. We recognize fully nevertheless that the losses from this cause are great.

Our failure to fully appreciate that plant symptoms do not provide an index to salt injury has been in part responsible for a second lack of understanding. It has long been held that below sometimes substantial concentrations of salts plants were not injured. In our recent work we have found measurable injury at relatively low concentrations of both chloride and sulphate salts. As the concentrations are increased in successive treatments the injury is progressively greater.

Our conclusions in this regard are different from the older ones, in part because of the absence of symptoms just mentioned but in part also for two other reasons. Physiologists have learned only within the past ten years or so that to produce a normal plant with nutrient solutions it is necessary to supply small amounts of elements such as boron, manganese and zinc in addition to sulphur, nitrogen, phosphorus, potassium, iron, magnesium, and calcium. The benefits of essential elements present as impurities in salts added to cultures have tended accordingly to more or less offset the injurious effects. In soils these lesser elements are rarely lacking.

As a result of recent work of Mr. Sokoloff of our laboratory we now know that the addition of sodium salts to soils stimulates the formation of nitrate by the break-down and loss of the soil humus. The temporary benefits sometimes observed when salt is added to soils I believe are usually those obtainable on a more abundant scale by nitrate fertilization.

The Date Palm

Few if any agricultural plants are thought to be more tolerant to salt than the date palm. Both Kearney and Swingle observed its growth in Northern Africa on very saline soils. But both investigators were impressed by the responses of trees following the removal of a part of the salt from the rootzone. Swingle points to the cultivation of the palm under conditions he thought would preclude other profitable cultures. He states that old date palms which had made a slow and stunted growth and which had fruited but little, at once grew luxuriantly and began to bear heavy crops when a "remarkably pure" irrigation water was substituted. Kearney points to the knowledge of Algerian natives in the practices of removing salt from soils. The date palm does not thrive best on, nor so far as we now know derive benefit from quantities of salt that are detrimental to other cultivated plants of desert areas.

(5) Eaton, Frank M. 1935. Salinity of Irrigation Water and Injury to Crop Plants. California Citrograph, Vol. 20, Nos. 10 and 11.

Table 1.

Concentrations of Sulphate, Chloride, and Nitrate in the Soil Solutions of a number of Coachella Valley grapefruit orchards

Soil No.	Location	Condition of trees	Moisture equivalent percent	Concentration of soil solution at moisture equivalent -- milligram equivalents per liter (1) Sulphate	Chloride	Nitrate
546	West of Oasis School	Very Poor	11.1	83.5	107.7	44.3
551	South of Oasis School	Fair	6.4	110.9	47.3	24.9
550	In adjacent native vegetation		3.1	20.6	42.9	6.9
558	South of Oasis School	Fair	12.0	73.2	23.7	20.0
559	East of Thermal	Fairly Good	15.0	13.7	14.1	0.4
560	South of Indio	Fairly Good	25.9	159.5	19.0	2 6
561	South of Martinez	Excellent	7.7	8.7	25.2	20.9
562	In adjacent native vegetation		3.8	0	26.6	1.8
563	Northwest of Oasis	Poor	10.3	16.9	37.0	3.0

(1) To convert the data reported in the above table to parts per million on the dry weight of soil, first multiply the reported concentration by the moisture equivalent percentage pointed off two places to the left and then multiply by corresponding factor as follows: Sulphate, 48; Chloride, 35.5; and Nitrate, 62. If the factor 14 is used for nitrate rather than 62 the result will represent parts per million of nitrogen.

Salt Concentrations In a Few Coachella Valley Orchard Soils

Very recently we have completed a laboratory examination of a number of soils from grapefruit groves of the Coachella Valley. This work, summarized in Table 1, was undertaken with the cooperation of H. B. Richardson of the University of California Extension Service.

The irrigation waters supporting these plantings, so far as they have been examined, have contained relatively little salt and yet substantial concentrations of salt were found in these soil solutions in nearly all instances.

The salinity conditions in nearly all of these groves are such that a recommendation in favor of some type of flood irrigation is advisable. Whether in basins or in contours sufficient water should be applied to effectively cover the surface of the ground and leach the excess salts from the rootzone. To what extent similar salinity conditions exist in other Coachella Valley orchards we of course can not state but we have no reason for believing that those selected are not representative of the furrow irrigated orchards.

Furrow irrigation is successfully practiced in the South Coastal Basin and elsewhere but for best results it can be used only where the winter rainfall is ample to leach downward and out of the upper root zone the salts which tend to accumulate in the ridges between the furrows during the summer time.

AFTERNOON SESSION

Introductory Remarks by A. F. Kinnison, Chairman

MR. HILGEMAN and I surely appreciate the opportunity that we have today to meet with the date growers in the Coachella Valley. It is my first opportunity to attend one of your Institutes and yet I have read all of the Proceedings from the very first. Mr. Hilgeman has been here before with the late Professor Albert, and both have been working on dates in Arizona for several years. We certainly think highly of your Date Institute. It has had a very favorable influence on the development of the industry. The need of this influence will continue, since we are likely to see increased development, possibly in the near future. There is an awakening in Arizona in the date industry. The depression stopped planting, as it stopped almost everything. Now, however, we learn that more people are interested in dates than ever before and that those who established small gardens in the late twenty's have no offshoots for sale. They have offshoots, but they are increasing their own plantings.

It is likely, with the development of new lands in the Colorado River basin in both Arizona and California that there will be considerable increased interest in dates. I think that meetings like this one, where we gain a better understanding of practices and conditions in the field, will enable commercial developers to keep their feet on the ground. We hope so. We want to avoid a boom on dates. It is an industry with which people must grow up in order to be successful.

How Much Water Does A Date Palm Use?

By Arthur F. Pillsbury, Junior Irrigation Engineer, University of California, Riverside

THE question of the amount of water used by date palms is of utmost significance to the date growers of Coachella Valley. If insufficient water is used in irrigating, an adverse effect can be expected on the yield and quality of fruit produced. Use of too much water, on the other hand, results in waste and an unnecessary increase in costs. Not only is the cost of pumping increased, but also the cost of labor in irrigating.

The University of California, Citrus Experiment Station, in cooperation with the Division of Irrigation, Bureau of Agricultural Engineering, United States Department of Agriculture, is at present making an irrigation study of the Coachella Valley region. This study is concerned with water resources, water quality, irrigation requirements for different crops, and irrigation practices. In connection with the irrigation requirement investigations, the use of water by the 3,100 acres of date palms in the Valley is an important item and is being given detailed consideration in the present work.

Plant-Soil-Water Relationships

The soil is a reservoir of water, which water is available, in certain definite amounts, to the roots of plants. The amount of moisture a given soil will hold, providing there is no restricted drainage, depends upon the texture of the particles making up the soil and upon the structure of the mass. When the downward gravitational movement of water has ceased (usually within 48 hours) after an irrigation, a given soil will hold a rather definite amount of water. This is called the **field capacity**, and is quantitatively expressed as a percentage of the dry weight of the soil. All soil wet will be at field capacity. Additional irrigation will not increase the moisture in the soil already wet, but will increase the depth of penetration.

To illustrate field capacity, this glass tube has been filled with soil classified as Coachella fine sand. The soil was first air dried, and 48 hours ago, after packing into the tube, a 2-inch irrigation was applied. The moist soil is now at field capacity. There has been no moisture increase in the dry soil. Note the clear line of demarcation between the wet and the dry zones. Another 2-inch irrigation will now be applied. Note that the moisture immediately starts to move downward. This will continue until, at the end of 48 hours, movement will have practically ceased. The moist soil, containing just the same percentage of moisture as after the first irrigation, will be twice as deep.

If it is assumed that root distribution is uniform and complete throughout a soil, plants can obtain

moisture readily whether the soil be wet to field capacity or dried down to what is called the **permanent wilting percentage**. Below the permanent wilting percentage some moisture may be available to plants, but insufficient to prevent wilt. Theoretically, then, after a soil has been irrigated, it is not necessary to again irrigate until the moisture has dropped to the wilting point. In practice, this conception needs modification. In the first place, a factor of safety is required because of the impossibility of applying water immediately a soil reaches the wilting point, and because of the normal impracticability of telling just where the wilting point is. Secondly, roots are usually not distributed completely and uniformly throughout the mass. With increase in depth, roots become fewer, so the upper soil is dried out faster than the lower soil. Further, the horizontal concentration of roots is not always uniform. As the zones of highest root concentration reach the wilting point, the plant for its transpiration needs must depend more and more on the roots in the lesser concentrated zones. This results in an apparent reduction in respect to rate of moisture extraction, provided there is no irrigation before an appreciable portion of the soil becomes deficient in moisture. Under moderate climatic conditions many plants will show no water-stress even though a considerable portion of the soil is dry. But when transpiration rates are high, as with date palms during Coachella Valley's hot summer months, it is important that no great portion of the soil reach the permanent wilting percentage.

The widely cultivated soils of Coachella Valley are, as a rule, sandy, low in organic matter, and extremely stratified and variable. They are derived from the parent rock material in the surrounding mountains; have been deposited by floods washing down; and have been extensively redistributed by wind action. It is the fine, flaky nature of much of the blow-sand so characteristic of the series of soils classified as "Coachella" that possibly give it characteristics not usually found in sandy soils. Most sandy soils have a low moisture-holding capacity, while the Coachella soils may, but not always, have an extremely high moisture-holding capacity. The most consistent thing about these soils is the wide variation in this property found within very short distances. However, by and large, the soils of this Valley hold when wet a surprisingly large quantity of available moisture.

In connection with the present study, many plantings have been found where inadequate penetration of moisture is obtained. This is true even on some of the sandier soils. In many cases this may result from failure to apply enough water, whether the irrigations be too infrequent or the individual applications too light. There is extreme variability in the rate at which the water percolates into the ground in different locations. It is felt that this difficulty can normally be corrected. Growers will do well to see that they get adequate penetration throughout the year. Poor penetration means at least a part of the root system cannot function, and it usually means insufficient water is being applied.

Soil-Moisture Studies of Date Palms

Plots have been established in several commercial Deglet Noor date gardens to study the use of water. Six or more trees within an orchard are blocked off and irrigated as a unit by flooding. The water applied at each irrigation is carefully measured. Then, three different times in the interval between each irrigation, soil-moisture samples are taken with a soil tube to a depth of 8 feet, excluding the mulch. A sufficient number of samples is taken so that the results will be representative of the average conditions in the plot. The samples for each two feet of depth are kept separate. Each sample is analysed in the laboratory and the amount of moisture in it is determined. The result is a complete picture of the soil-moisture changes from each irrigation to the next. The rate of soil-moisture use as determined by this sampling process is called the **consumptive use**.

There is some evaporation direct from the mulch (which is that top cultivated portion of the soil containing no roots). There is, or should be, some deep percolation below the root zone. And in furrow irrigation there is often some surface runoff. Consequently, it cannot be expected that all moisture applied will be accounted for in consumptive use. The ratio between consumptive use and water applied, expressed as a percentage, is called the **efficiency**. Efficiency will vary with the method of irrigation, with the soil type, and with the care with which the water is applied.

Before approximately accurate average data are obtained as to consumptive use, it will be necessary to have a number of years' records. At present records have been obtained for only one year, so results herein reported are preliminary and must not be interpreted too closely. Table 1 gives such consumptive use records as have been obtained. Soil moisture was deficient at times during several months in Plot 2, and records of these periods are not included in the averages. Included also in Table 1 are the amounts of water actually applied and the efficiencies found. Data for Plot 9 are incomplete and cannot be included as yet. Note how consumptive use increases from a low in January, of 2.8 inches depth (acre-inches per acre), to a maximum in July of 11.5 inches. Note also that April was a month of extremely high use. The average totals for the year —9.1 feet applied to supply the roots with 6.8 feet of moisture—indicates a much higher water requirement than any heretofore determined by this division in other sections of California.

Depth of Roots

Since soil moisture samples were taken for each 2 feet of depth to 8 feet it has been possible to deter-

Table 1

Consumptive Use of Water — Coachella Valley Date Palm Plots

April, 1936, to March, 1937. Acre-inches per acre

Plot No.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mch.
1	10.4	8.7	10.2	11.5	10.4							
2	4.0*	8.5	7.5*	7.4*	8.4*	6.5*	5.6	4.3	3.4	2.6	4.2	5.3
3	9.6	7.5	9.2									
9						7.7	4.0	3.4	3.2		3.7	6.2
10.						7.1	5.3	3.1	2.8	3.1	5.0	5.8
Av.	10.0	8.2	9.7	11.5	10.4	7.4	5.0	3.6	3.1	2.8	4.3	5.8

Average total for year=81.8 acre-inches per acre (6.8 ft.)

*Moisture supply deficient. Not included in averages.

Water Actually Applied — Acre-Inches per Acre

Plot No.	Efficiency	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mch.
1	80%	13.0	10.9	12.8	14.4	13.0							
2	73%		11.6					7.7	5.9	4.7	3.6	5.8	7.3
3	66%	14.5	11.4	13.9									
10	78%						9.1	6.8	4.0	3.6	4.0	6.4	7.4
Av.	75%	13.8	11.3	13.4	14.4	13.0	9.1	7.2	5.0	4.2	3.8	6.1	7.4

Average total for year=108.7 acre-inches per acre (9.1 ft.)

mine rates of moisture extraction for each depth. This indicates comparative root concentration at the different depths. Results for all plots, expressed as a percentage of the total consumptive use, are shown in Table 2. Considerable differences will be noted between the plots. In light of the extreme variation in soils encountered, this is not surprising. Most significant is the small amount of root activity below 6 feet. In 1932 some preliminary work was done in studying root activity for each foot of depth to 18 feet in a number of orchards. These data indicated that although there may be some root activity below 8 feet, it is not measurable by the methods employed. In the present work, therefore, no sampling is done below 8 feet.

Table 2
Depth of Root Activity
As indicated by rates of moisture extraction at different depths

Plot No.	Depth 0'-2'	2'-4'	4'-6'	6'-8'
1	42%	49%	6%	3%
2	69	21	7	3
3	40	41	14	5
9	70	22	6	2
10	37	36	22	5
Av.	52%	34%	11%	3%

Leaf Growth

It is desirable in the present study that information be gathered to show that irrigation has been adequate to meet the needs of the palms in producing a good yield of good quality fruit. It is possible that the trees will be under partial stress at times with a resultant damaging effect on the crop, without that partial stress showing up in the soil-moisture curves. Therefore, it is essential that some check be made on the trees to try to determine if they have at all times had sufficient soil moisture available.

Probably the best method is to study yields and quality of the fruit produced, but this involves the setting up of a group of elaborate differential treatments which should be carried on over a long period of years. Growth studies of fruit itself have been employed extensively with other crops, but this method is impractical with date palms. Not only are fruit measurements difficult to make at frequent intervals on a great number of palms, but the growth period is too short for any practical use in this respect.

Periodic measurement of the growth of new leaves at the top of the palms was finally selected as a promising means of studying the adequacy of irrigation treatments used (1). The method involves the attaching of a fine wire to one of the small new leaves, running that wire down the tree through screw-eyes, and weighting the end with a nail. The growth is determined by periodically measuring the distance from a fixed datum to the nail on the end of the wire.

On figure 1 is shown 4 series of measurements, each being an average of 4 leaves. Note that, where climatic conditions do not vary, growth rate is almost uniform for a period of 2 months or longer. However, while the leaves are still in a vertical position, growth appears to slow up and stop very suddenly. Wires can then be transferred to new leaves and the measurements continued.

On Plot 2, for which this record is shown, there appeared from soil-moisture studies that there might be periods of partial water-stress prior to irrigations. No such stress shows up on the growth curves as drawn. But when the actual growth rate per day for each interval between measurements was plotted on the same chart, existence of periods of stress just before several irrigations appeared probable. These periods are pointed out by arrows. Note that in the interval following each, when the plot was irrigated, growth rate is much greater. A study of climatic conditions during these intervals does not reveal any other reason for the marked change in growth rate. There is also reason to believe that depressed growth would have been evidenced near the end of the records for the first two series of leaves. However, the wires were kept on the leaves too long to get any significant record in this respect.

It is felt that a soil-moisture deficiency is quickly reflected in leaf growth rate, and this method appears to hold promise as a means of determining the adequacy of irrigation treatments. However, methods employed in 1936 had a number of faults which led to inaccuracies in measurements. Steps are now being

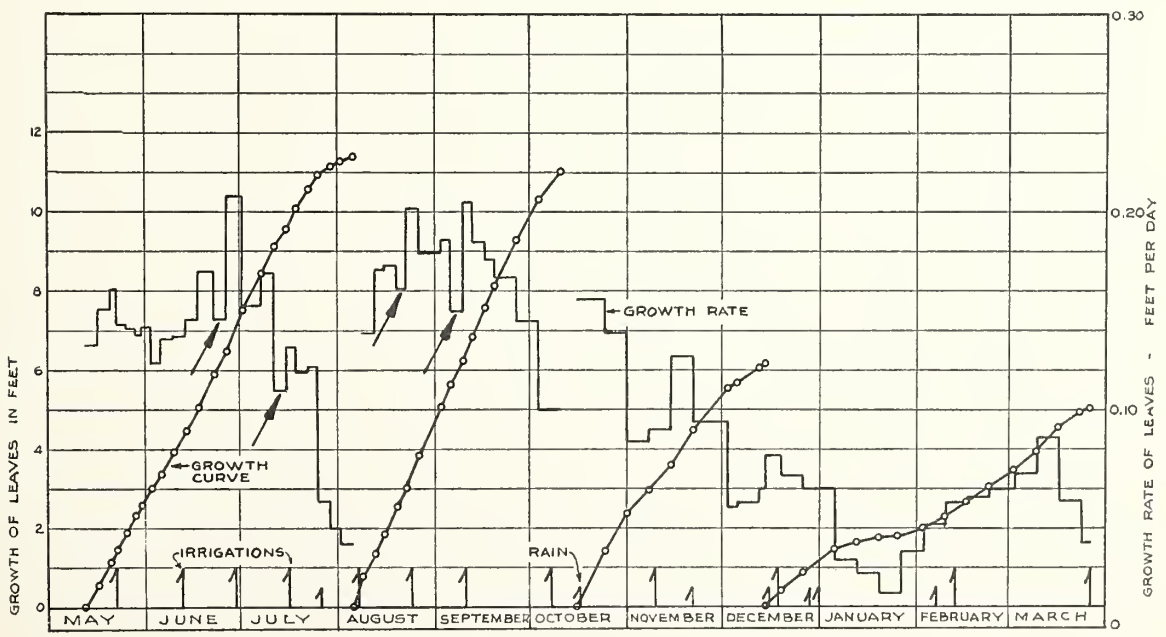

Figure 1: Chart showing growth and growth rates of leaves of date palms at plot no 2, May 1936 to March, 1937. Arrows indicate periods during which trees were apparently under partial water stress.

taken to correct these faults, and it is hoped that future records will show more definitely and clearly any deficiency in soil moisture.

All plots are located on plantings of the Deglet Noor variety. Measurements on other varieties indicate extreme variation in rates of growth, while rates on all Deglet Noor plots appear, although not as yet carefully analysed, to be remarkably uniform throughout the Valley.

Conclusions

The preliminary data here presented, indicating the water used and the water required for the irrigation of several plots in commercial Deglet Noor date gardens, is of course subject to modification as the work is continued in the future. However, there is an unmistakably high water requirement, especially in the summer months. The total average depth of 9.1 feet of water applied in the past 12 months may be exceeded in many places with a resultant lower efficiency. But there is not much reason to believe that the consumptive use ran much over 7 feet in this valley during that time. Certain it is that there are many plantings in which the consumptive use was less because of the existence of periods when there was a deficiency in soil moisture.

Present results indicate that the palms take an average of 5/6 of their moisture from the top 4 feet, excluding the mulch, and 1/10 from the 4 to 6-foot depth. This in no way must be construed as meaning that the soil may be left continuously dry below 6 feet or even 8 feet. This morning's paper by Dr. Eaton indicates the desirability of some leaching. However, once the soil is wet below 8 feet, it will remain wet even if irrigations only very occasionally penetrate deeper.

It is impossible in the present study to attempt to determine the absolute effect of short periods of partial water-stress on the fruit of the date palm. But it is known that where soil-moisture deficiencies do not occur that good yields of high quality fruit are obtained, cultural practices and environment conditions being adequate. It is, therefore, the objective in this work to not only determine consumptive use but, by leaf growth measurements, to check the adequacy of the treatments under which those determinations are made. It is further hoped that growth measurements will be found to be of practical use to the growers in any possible adjustment of their irrigation practices.

(1) Similar measurements have previously been made at the Arizona Experiment Station by Vinson and at the U. S. D. A. Date Gardens at Indio by Mason to correlate leaf growth with temperature and sunlight. "The minimum temperature for growth of the date palm and the absence of a resting period. Partial thermostasy of the growth center of the date palm. The inhibitive effect of direct sunlight on the growth of the date palm." By Silas C. Mason. Jour. Agr. Res. 31:401-468, 1925.

The Crude Fat Content of Date Skins Correlated With Moisture Damage

By R. H. Hilgeman and J. G. Smith, University of Arizona, Agricultural Experiment Station

FOR several years previous to this study, tests were made with various oil and wax sprays in an effort to make the skin of the date less permeable to water, subsequently reducing the loss from checking and splitting. The results were unsuccessful; however some observations were made worthy of note. If the oil or wax was applied without dilution, the loss from splitting was reduced but in many cases a burning of the fruit occurred. In some instances the dates failed to mature and several clusters sprayed early in the season were still green in December. If smaller amounts were applied, so that the rate of ripening was practically normal, the loss was about the same as on the untreated dates. Varieties which had a tendency to shrivel, were found to maintain their moisture more uniformly when sprayed. In the majority of the cases the mineral oils gave better results than the vegetable oils, however neither were sufficiently successful to warrant commercial application of the sprays.

To further study waxes and oils and their possible relationship to losses from moisture damage, a series of tests of the crude fat content of date skins was begun by the late D. W. Albert, in the fall of 1935. These preliminary tests which are reported in the forty-seventh Annual Report of the University of Arizona, Agricultural Experiment Station, showed a marked difference in the amount of crude fat in the skins of two varieties tested. This paper is a report on further tests based on samples collected in the fall of 1936 which were analyzed by the writers after the death of Mr. Albert.

Six varieties were selected which ranged from one of the most easily damaged to one of the most resistant. The skins were removed from 100 ripe dates of each variety and soaked in water for about four months. Every two weeks the water was drained off and the skins washed in fresh water to remove all adhering pulpy material. Samples of each variety, approximating two grams, were dried to constant weights and placed in alundum thimbles. The crude fat was extracted with ether, as outlined by Mahin and Carr, allowing the refluxing to continue for 20 hours until all of the substances soluble in ether, were removed. After refluxing, the samples were dried to a constant weight, the loss noted and the per cent of loss calculated as crude fat. Since ether is a solvent for many types of waxes and fats, this percentage includes all of these substances which are grouped together and classified as ether extract or crude fats.

The table (page 17) sets forth the data obtained in these tests, the average loss for the past five years, due to moisture change and fungi, the types of loss and the relative time of ripening.

The percentages of loss, shown in table, include all losses such as souring, spotting and shriveling. It was not possible, from the records available, to segregate the losses due directly to rain. However, this data is sufficiently accurate to use in this study. These records are from the University of Arizona Date Garden at Tempe, which, because of its location, is subject to heavy moisture losses. Therefore, these percentages should not be considered as the losses for these varieties in other Salt River Valley date gardens.

If only soft dates are compared, it is evident that there is a definite

Table I.

Variety	% Crude Fat*	% Loss	Time of Ripening	Type loss due to moisture damage
Hayany	2.52	54	Early	Severe to moderate checking blacknose
Iteema	2.77	60	Mid-season	Checking, splitting, tearing
Red Timdjouret	2.94	91	Early	Severe checking, blacknose
Khadrawi	4.18	13	Early	Slight splitting Moderate to slight checking
Deglet Noor	6.07	62	Late	Severe to moderate checking Blacknose, tearing
Maktoom	7.42	9	Late	Slight checking, slight splitting

*Ether Extract—fats an d waxes soluble in ether.

relationship between the crude fat content of the skin of the date and its resistance to rain damage. The varieties which had the largest amount of crude fat were the least damaged by high humidity and rain. The semi-soft Deglet Noor variety is the exception in this study, as it has a high percentage of crude fat, yet it has been subject to heavy losses.

Although the varieties which have the highest crude fat content were the least damaged, it must not be assumed that this is the only factor involved. It has been observed that losses due to splitting and tearing are closely related to the degree of maturity and the sugar and moisture content of the date. Also, it may be pointed out that these losses are based on a five-year average, and no one year would possibly show the same relative losses. Another factor which may have some bearing is the thickness and texture of the skins. No studies were made on this line of investigation.

From the above data, it would also appear that there may be a relationship between the crude fat content of the skin and the time of maturity. This is further substantiated by observations made as to the effect of oil sprays. However, the number of tests made in this study is entirely too limited to make a definite statement as to this relationship.

To further study this problem, tests will be continued next year using a greater number of varieties. Also, qualitative tests to determine the identity of the constituents of the ether extract are to be made by the Food Research Division of the United States Department of Agriculture, at Washington.

The Substandard Date Diversion Program of 1936-1937

By Hugh W. Proctor

THE problem of the disposition of the substandard dates, commonly called No. 2 drys, has for several years been one of the most serious faced by the date growers of Coachella Valley and has caused considerable difficulty in the orderly marketing of the better grades of dates. It has been the general experience of all growers of Deglet Noor dates that a certain percentage of the dates produced will be dry, the percentage of these drys depending on the care given to the garden by the operator, the type of soil on which the dates are grown, the amount of thinning done, seasonal conditions and other factors. These dry dates are divided into three classes:

1. Semi-dry dates, or those dates which are dry on the calix end and soft on the other end, commonly called waxy tips. This grade of date is in every respect equivalent to the choice grade except that it has the hard end. It is the best grade of date for hydration purposes, because it hydrates very quickly and retains its color and to some extent its natural flavor.

2. Hard dry dates. These dates are quite dry and hard and are similar to No. 2 dry dates in every respect except in size, the requirement being that they shall not be smaller than 50 to the pound.

3. No. 2 dry dates. These are hard, dry, small dates which have a count of not less than 50 nor more than 70 to the pound, and contain, in the edible portion thereof, not in excess of 17 per cent moisture.

The substandard grade which was set up by the diversion corporation includes all the No. 2 dry dates, and in addition includes dates which have defects such as black-nose, scars, hard ends or deformitives, count no less than 42 nor more than 70 to the pound and, in the edible portion thereof, not in excess of 25 per cent moisture. Generally speaking, it has been the practice of date growers to sell this substandard grade fruit during the harvesting season to any date buyer that could be found, without any restrictions as to its use. The result of this practice was that nearly all of this low grade fruit was hydrated and sold directly in competition with the better grades of dates, and most often was used as competitive ammunition by the dealers who cared little or nothing for the future welfare of the date industry. The direct result of this manner of marketing the substandard dates has been to lower the general price level of all California dates, and to create in the minds of the buying public a rather low opinion of California dates.

An attempt was made in 1933-1934 to establish a dry pool of substandard dates, the object being to hold this grade off the market until the better grades were sold. This program failed, due to lack of adequate financing and to the fact that no market for date by-products had been established, and also to lack of grower cooperation. The present program of handling substandard dates was instituted in the fall of 1936. It was made possible by an act of the 74th Congress approved on August 24, 1935, which was designed to increase the consumption of agricultural commodities through diversion into new outlets. The date diversion program provided for the purchase of substandard dates and their sale for by-product purposes. The plan provided for the payment of an indemnity or subsidy representing approximately the difference between the growers' cost of production and the market price of such commodity for manufacture into by-products. Accordingly, in September, 1936, a movement by the date growers of Coachella Valley was started to enter into an agreement with the Secretary of Agriculture to finance the purchase of substandard dates in order to divert them from the regular channels of trade. For the purpose of obtaining a contract, it was necessay to have a corporation

composed of dates growers, and inasmuch as the Coachella Valley Date Growers, Inc., had not been dissolved, although inactive at the time, and as this corporation seemed entirely suitable for the purpose, it was chosen to act as the diversion corporation for the growers. After making a few necessary changes in the by-laws of this corporation and much preliminary consideration, a contract between the Coachella Valley Date Growers, Inc., and the Secretary of Agriculture was agreed upon and signed.

Under the provisions of this contract, the Coachella Valley Date Growers, Inc., agreed:

1. To purchase from the grower substandard dates of the 1936 crop, produced in California and Arizona according to the terms of a substandard date purchase contract, which the grower was required to sign. The price paid to the grower was 7½c per pound, less ½c per pound for the administration expenses of the corporation.

2. To maintain an inspection service so that no dates would be bought which did not conform to the specifications of the substandard grade.

3. To store the dates purchased in a suitable bonded warehouse where they would receive proper care, and warehouse receipts could be obtained for collateral.

4. To take all reasonable steps to market these dates prior to July 1, 1937, for diversion prior to January 1, 1938.

According to the contract, sales were to be made only for conversion by the buyer into crushed dates, date flakes, date sugar, date crystals, date brandy, alcohol, stock feed or into any other by-product that the Secretary of Agriculture might approve. Minimum prices for which these dates could be sold were established by the Secretary as follows:

Use	Pounds	Minimum Sales Price
Crushed dates Date sugar Date flakes	1,200,000	$0.04 per pound
Brandy and Alcohol	100,000	.02 " "
Stock feed	200,000	.01 " "

5. To furnish the Secretary a conversion certificate on every lot of dates sold by the corporation containing an affidavit by the buyer that he has converted the dates bought by him according to the terms of the contract, and an affidavit by the inspector of the corporation that he has investigated the accounts of the buyer and has personal knowledge that the dates have been converted. Under the terms of the sales contract, if satisfactory proof of conversion is not supplied the buyer is subject to a 7c per pound penalty, in addition to the purchase price and the corporation cannot collect the indemnity from the Secretary of Agriculture. For his part of the contract, the Secretary agreed to pay to the corporation the difference between the purchase price of the dates and the sales price, limiting the payment to 1,500-000 pounds of dates.

In actual practice, instead of selling the dates for the account of the grower and then applying to the Secretary for an indemnity covering the difference between the purchase price and the sales price, a loan was obtained by the corporation from the Reconstruction Finance Corporation under the terms of which the Secretary of Agriculture agreed to reimburse the R. F. C. not to exceed $85,000.00. Under this arrangement, the Coachella Valley Date Growers, Inc., was able to pay the grower the full purchase price of the dates. This procedure was very much better for the grower in that he did not have to wait until his dates were all converted before receiving payment. At the beginning of the 1936 season, it was estimated that there would be approximately 1,500,000 pounds of substandard dates to be purchased. This estimate proved to be remarkably accurate, as the corporation has actually purchased 1,-240,770 pounds and probably 300,000 pounds were not delivered to the corporation. The entire date production of the 1936-1937 season was 7,500,000 pounds, and due to seasonal conditions an abnormally large percentage of this crop was dry. Under average conditions, not more than 15 per cent of the date crop should be substandard.

In consideration of the difficulties encountered in starting a new program, the fact that a late start was made and that the crop of dates matured abnormally early, that the contract was not signed by the Secretary of Agriculture until October 22, 1936, that first payment to the grower was made in January, and that he had to harvest most of his dates and hold them in storage at his own expense only on a promise of a contract from the Secretary, during which time cash date buyers were constantly telling him that the program would fail, that he would not get his money and that the dates would suddenly be released only to flood the market and further depress the price of all dates, it is, in my opinion very commendable that the date growers as a whole cooperated so completely. The diversion corporation received more than 80 per cent of the substandard dates produced in the Coachella Valley during the past season.

The benefits of this program to the date grower and to the date industry have been great and varied.

1. **Cash benefit.** The grower received a certain amount of ready cash which he would not otherwise have had. This benefit, while substantial, material and greatly appreciated by the grower, coming during a season with an abnormally large amount of dry dates which otherwise might have been financially disastrous to him, was by no means the most valuable accomplishment.

2. **Growers cooperation.** As this program received the approval of practically all of the date growers, and as it was necessary to have an association of all date growers in order to put it over successfully. They found that they could work together, forgetting all their past disagreements and differences. It has been most unfortunate that this great date industry, producing the most romantic and historical fruit in the world, having attracted men as growers who have more intelligence and business ability by far than any other class of farmers; men who have come to a desert country, have endured trying hardships and displayed untold fortitude, have been lavish in the expenditure of money on the development of their gardens, have been unceasing in their efforts to produce high quality fruit and develop new varieties, should have found the problem of marketing and national distribution such a serious stumbling block.

3. **The development of a market and the use of substandard dates as a manufactured by-product.** This promises to be the greatest of all the benefits to the date industry and to the grower, and cannot be calculated in dollars and cents. It is far reaching in its possibilities and should grow in value to the producers during the coming years.

The sale of substandard dates has been for the following purposes and uses:

Date flakes, 700,500 pounds; crushed dates, 120,000 pounds; date brandy, 140,000 pounds; Cocoanut roll or Jumbo dates, 225,000 pounds; date sugar, 50,000 pounds. These above dates have been removed from the regular channels of trade and from competition with the better grades of fruit, and are to be manufactured into wholesome food products which should meet favor with the American public and grow in popularity.

Approximately two-thirds of these dates will be made into date flakes. For this purpose, the Beaumont Fruit & Cold Storage Company located at Beaumont, California, a California corporation, was organized by Mr. L. W. Covert, for the specific purpose of manufacturing and marketing date flakes on a national scale. Date flakes have been manufactured in a limited way during the past five years under processes developed by Harry L. Boynton, a former resident of Beaumont. This product has met the test of sanitariums and health food stores, which are constantly in search for new foods, and is growing in popularity with the general public.

The crushed date is manufactured by the Garden of the Setting Sun located at Mecca, California, and has been developed over a period of years during which it has found a constantly increasing demand. It has the merit of being a blended product, using several varieties of dates which might be well adapted for other purposes.

Date brandy is being manufactured in Los Angeles by a former resident of Coachella Valley. This is a comparatively new product which has not yet been put on the market, but it appears to have interesting possibilities due to the flavor and quality of this beverage, and also due to the fact that any dates so used will completely lose their identity as dates.

The cocoanut roll or jumbo date is not a new product, but has been on the market for many years, usually made from imported dates. Only recently has this product been made from California dates, and it is found to be much more desirable in every respect than that made from imported dates. The California Date Growers Association is manufacturing this product in a limited way this year and have been turning out a product which retains the natural Deglet Noor flavor, can be sold at reasonable prices, is clean, wholesome and delicious and will, I believe, find a ready market.

In carrying out the diversion program of 1936-1937, the management and the directors of the Coachella Valley Date Growers, Inc., have received valuable assistance from Mr. E. L. Markell and Mr. William F. Cowan, Jr., of the Agricultural Adjustment Administration, who have been untiring in their efforts in working for the success of the diversion program, have shown great personal interest in the date industry, and have given their time freely in helping to solve the problems that have risen from time to time, beyond the necessity of simply fulfilling their official duties A great deal of the credit for the success of this program is due to their efforts.

It is expected that there will be a similar diversion program for next year, and that a much greater benefit will be derived by the grower than from last year's program since the corporation anticipates that it will be in a position to purchase the dates as they are harvested and thus avoid some of the unsatisfactory delays which occurred this season.

The Agricultural Adjustment Administration has indicated that if an agreement of this nature is entered into for the coming season it will be necessary for the industry to set up a program that will definitely provide for the segregation of all substandard dates on a basis that will assure their removal from competition with the standard grades. If this can be accomplished with 100 per cent of the substandard dates next season's program will be of even greater value to the date industry than this past season's efforts.

-:- -:- DISCUSSION -:- -:-

Led by R. W. Nixon

Nixon: Everybody knows by now that last January Southern California and Southwestern Arizona were visited by a freeze of unprecedented severity. The only comparable freeze previously recorded appears to have been in 1912-13 and even then the minimum temperatures in Coachella Valley were not quite so low. At that time there was no commercial date industry as the large importations which led to the present plantings were just being made. There is very little in the records as to what happened to dates in that freeze. So most date growers up until last January believed that dates were in the privileged class, exempt from liability to damage from low temperatures.

The low temperatures which occurred were entirely unexpected. On the night of January 21 date growers in Coachella Valley listened to a radio prediction of a minimum of 21° and went to bed without worrying for temperatures of short duration between 20° and 25° have often occurred without appreciable damage to palms. But next morning it was discovered that the actual minimum had dropped 8° below that predicted and that the date palms were beginning to show signs of distress.

The committee in charge of the program for the Date Institute thought some record should be made of just what has happened and that the best way to handle the topic would be, not as a formal paper on a subject about which little can really be formulated at present, but an informal discussion by date growers. Of course, the full story cannot be told until after the palms have come back to normal which in many instances will be at least two years, but the time to record observations are while they are fresh in our minds and whether or not we get any immediate benefit from this present discussion it may be of some value in the evolution of cultural practices in the future.

We will take up the discussion in three divisions: first, temperatures; second, what has happened to the palms; and third, a general summary. As an introduction to the subject of temperatures, I have asked Mr. Dewey Moore to give us a resume of the temperatures that occurred during the freeze. He has kept the meteorological records at the U. S. Experiment Date Garden for the past several years.

Dewey Moore: I will show briefly the minimum temperatures occurring beginning in 1908. The lowest temperature occurred this past January, the lowest previous having been in 1913. The highest absolute minimum

temperature was 30° in 1920. In 1913 the temperature was 15°, in the year following the lowest temperature was 28° with only four days with a temperature below 32°, which is the lowest record for days having temperatures at freezing or below for any one year. From that we might say that this coming winter may be one with very little cold weather.

As to the freeze this year, the lowest temperature was 13.4°. It was 32° and below for 14 hours, 30° or below for 13 hours, 29° and below for 12½ hours, and 20° and below 4 hours and 50 minutes. The lower point of the wedge-shaped graph shows the duration of the lowest temperature for a little over one hour. The total hours below 32° during the winter was 187 hours and 5 minutes. It was below 20° for 10 hours and 5 minutes, and below 18° for 5 hours and 20 minutes.

It might be of interest to note the temperatures of Imperial Valley furnished by the meteorologist at El Centro. The lowest temperature recorded in Imperial Valley was 14° at Imperial. At Brawley it was 18°, Calexico 16.8°, Holtville 15.2°, Calipatria 22.4°. Another station in the Coachella Valley located at Oasis gave a reading of 17°.

Nixon: In general the minimum temperatures in Coachella Valley were lower than those recorded at other points. Mr. Moore has given the temperatures for Imperial Valley. While at Sacaton, Arizona, the minimum was 14°, with 20° or below for 9 hours, it was only 19° at the Tempe Date Garden and apparently around 18° was the lowest in any of the date sections of Salt River Valley. At Bard, Calif., it was 17°. At the Yuma Valley Station it was 14°; at the Yuma Mesa Station, about 2 miles away, it was 19°.

In Coachella Valley, since there are more dates here, we can study the effects of the freeze to good advantage. The minimum temperatures seemed to have followed the lowest points of the Valley from northwest to southeast. The temperatures were a little higher along the edge of the mountains. It was about the same at Arkell's and Cook's as at Indio. The minimum at Palm Springs was 18°. Mr. P. L. Day reported 15°. In the La Quinta section on down to the Narbonne Ranch and Oasis the lesser damage to palms indicated somewhat higher minimum temperature than in the center of the Valley. In general, it seemed to be slightly warmer in the lower end of the Valley. At least the damage observed to dates of the same varieties according to size was a little less there.

As to what has happened to the dates I will begin by calling on Mr. Bert Cavanagh from the Indian Wells section.

Bert Cavanagh: I hope my few brief remarks won't be construed as a scientific observation on frost damage this past winter. I have noticed that young palms have had as much as 90% of the top frozen. Now they are not looking so bad, with the new growth. In palms up to 7 years there seems to be a damage of about 60% in the complete top of the palm. In palms of 12 years there was less damage than in any other case, about 40%. I do not know what the result is going to be on the coming fruit crop. I know that in young palms of about 5 years I attempted to prune off the leaves affected and in a good many cases I pruned up to the present fruit blossoms and still found leaf bases discolored.

W. G. Jenkins: I noticed that the cold damage had followed a direct ratio with the age of the trees. The oldest trees, about 3 miles out on the Palm Springs highway, planted about 1914, did not seem to be damaged much by the frost, but the young trees of 6 to 8 years old seem to be damaged the most. When the freeze came, on Friday, Saturday and Sunday mornings, we were dethorning, and two days later the sap was running out of the fronds and got on the clothes of the men and on the ground, leaving a white substance. Then the leaves started turning brown. I do not know what will be the result on the quality of the fruit.

L. Swingle: We are fortunate that our common variety, the Deglet Noor, is one of the more resistant varieties to cold weather. In the Persian Gulf region the Zahidi has the reputation of being the most hardy variety but this winter has shown that there is little difference between it and Deglet Noor in this locality.

The varieties that appear most injured by the cold weather this winter are Khadrawi, Khalasa and Maktum which lost all their leaves wherever exposed to any great amount of cold. Saidy and Halawi were both badly hurt but on the whole not so badly injured as the three mentioned above. Berhi and Sayer also seem to be in the intermediate class although there are not so many palms to make a proper comparison on these varieties.

A characteristic of soft varieties that does not seem to occur in Deglet Noor, is one leaf completely dead and another close by or even older that is apparently not injured. Injury on the Deglet Noor seems always to progress regularly from the completely frozen older and lower limbs to the green leaves apparently not hurt in the crown.

Seedlings and males vary considerably, some palms being badly hurt and others very little, but on the whole the males were hit quite hard. These palms show the same variation in cold resistance that they do in other characteristics and there is no way to tell before hand which palm will suffer and which will not.

The Deglet Noor is a native of the desert region of North Africa where the climate probably shows the same variation and extremes of heat and cold that we experience here and so seems better suited to the Valley in this respect than Khadrawi from lower Mesopotamia or the Khalasa from central Arabia. In general the African varieties seem to have withstood the cold better than the Persian Gulf dates.

My list of varieties proceeding from the most to the least injured would be as follows:

Leaves badly frozen: Khadrawi, Khalasa, Maktum. Intermediate: Halawi, Saidy, Berhi, Sayer. Most resistant: Dayri, Thoory, Tazizaoot, Deglet Noor, Zahidi.

Nixon: I think it is important to get as many different observations as we can. It seemed to me that on some varieties, particularly the Deglet Noor, the damage was more obvious right after the freeze. Other varieties such as Halawy and Khadrawy did not appear severely damaged at first, but after a few days the leaves began to take on a reddish brown color which was soon seen to be concentrated in streaks between some of the secondary veinlets, other portions of the leaflet remaining green. Later on, after 3 or 4 weeks, these reddish brown streaks began to dry up and at the present time most of these streaks are composed of dead tissue, although there are a few reddish brown on some palms. On a few of the lower leaves of several varieties I tagged a number of leaflets to see if there would be a progressive change in these reddish brown streaks and found that for the most part all leaflets were dead in six weeks time.

R. H. Postlethwaite: Minimum temperatures below 32° F. as registered on thermograph located in the

open but enclosed in official shelter box at Experimental Station, Indio. Approximately at sea level.

Jan. 3	29° F.	Jan. 19	31° F.
" 4	28°	" 20	26°
" 5	26°	" 21	25°
" 6	30°	" 22	13°
" 9	27°	" 23	18°
" 10	23°	" 24	18°
" 11	26°	" 25	23°
" 12	28°	" 26	24°
" 13	30°	" 27	26°
" 14	28°	" 28	26°
" 16	28°	" 29	30°
" 17	29°	Feb. 2	29°
" 18	27°	" 10	30°

These temperatures registered between 4 and 6 A. M. and only lasted about 1½ hours.

The resultant effect of the above temperatures can only be generalized, certain parts of the Valley are naturally colder than others, the elevations ranging from 200 feet below to 250 feet above sea level, records show that at an elevation of 75 feet below the minimum temperature shown by a thermometer 4'6" from the ground suspended on a leaf in the open air 4 feet from the palm trunk showed an average of 3.75° F. lower than on the Experimental Station thermograph.

Young Palms. One to three years old of all varieties show severe damage, many of one year old will probably die although those covered with burlap have suffered much less than those uncovered.

Palms 4-6 years old. Deglet Noor variety show fully 50 per cent of their leaves more or less brown but inner leaves without damage. Zahidi, Menakher and Khustawi variety very little affected. Khadhrawi and Halawi, much more affected with probably 75 per cent of brown leaves but inner leaves unaffected.

Bearing palms. Eight to twenty years old, Deglet Noor and Zahidi varieties very slightly affected, palms which have had full fertilization show slightly more brown than those which had little or none. Khadhrawi and Saidy varieties show probably 30 per cent of brown leaves. Barhi shows a little less brown.

All the above must be accepted only as an attempt to give a general average, some districts show more damage, there also is a difference in favor of a large garden compared with a small planting in the open desert.

A further report in April will probably show very little permanent damage but in the case of a large percentage of brown leaves the fruit will require very heavy thinning, as the fruit buds were formed before the freeze and are located in the insulated part of the trunk, full number will probably be produced but due to the lack of chlorophyll the palm will be unable to produce sufficient sugar to mature a full crop.

R. H. Gray (near Calexico), Imperial Valley: I have not noticed other than our own grove. Ours are all three year old palms. We have principally the Zahidi, Thoory and Halawy. The Thoory had recently been pruned and disced, as had the Halawy. The Zahidis were not pruned at all. There was very little damage on the Zahidis, quite severe damage on the Thoory and very severe damage on the Halawy. I do not think any of the palms were killed. Our minimum temperature was 15°.

Nixon: I made a trip through all of these regions a few weeks ago. At Westmorland I saw an 8-acre planting of Saidy very slightly damaged. I visited the old Reed and Williams plantings east of El Centro and found very little damage except on some of the Khadrawys. Near Brawley the damage was very slight in the Anderson date garden. In several instances there were opportunities to compare the Zahidi with some of the others such as Khadrawi and Halawy and there was distinctly less damage on the Zahidi. Dr. Swann near El Centro has an experimental planting with a number of varieties and the damage there was quite comparable to that at Indio. I found that the differences were not the same in all orchards.

Going on to Yuma Valley, there are several large plantings near Bard, the oldest of which is, I believe, about 4 years old. One of the growers is here, Mr. A. E. Collins.

A. E. Collins: I really haven't very much to add to the general information. I was there about February 1. Our Khadrawys seemed to be growing the fastest and seemed to have received the most damage from the cold. Checking on some seedlings I found they were damaged very much when they had been irrigated or fertilized. The tender, fast-growing palms seemed to be more affected than the others. Our larger Zahidis seemed to stand it the best. We had some 7 or 8 year old Zahidis that looked about the same as the Deglet Noors around here. The worst hurt were the young Zahidis, which we planted in 1935. We will lose a few of those. My partner writes me that since then the recovery has been quite rapid all over the grove. Our temperature was about 15°, and my thermometer was checked.

Nixon: Mr. Collins made one interesting observation, that is, his most severe damage was on young palms of the Zahidi variety. It seemed that small palms, one or two years after planting, showed very little difference between varieties. After that we begin to see differences in the extent of injury according to variety.

R. H. Hilgeman, Tempe, Arizona: The temperatures in the Salt River Valley were not as low as those recorded here. The lowest temperature at the University Date Garden occurred on the morning of January 24th. On this date a low of 19° was recorded with the temperature below 24° for 10 hours. This had been preceded by temperatures of 23°, 21° and 20° on the 21st, 22nd and 23rd, respectively. As nearly as I could determine, the lowest temperature in the valley was 18°.

Because of the difference in age and condition of the palms in the various date gardens, it has been difficult to classify the varieties as to their resistance to freezing damage. In general the ones that withstood the freeze the best were the Zahidi, Thoory and Tazizoot, while those that were damaged the worst were the Maktoom, Khalasa, Khadrawy and Halawy. Losses on these less resistant varieties ranged from about 30 per cent to 100 per cent defoliation, depending upon the age, condition, and location of the palms.

In checking the effect of the freeze, it has been observed that citrus trees which were irrigated during the time the low temperatures occurred were damaged less severely than those which were dry. However, I have not been able to determine any marked effect on the irrigated date palms. I wonder if any of the date growers over here have made any observations on this practice?

J. C. Jones: I have a small garden at Oasis. At the upper end I had some egg plant which I had to water. The water is warm, about 98°. I had no damage on dates. We had some young plantings that I did not irrigate and these were not damaged either. I irrigated all during that cold spell and I know that mine were not hurt as bad as some others nearby. My trees are six and seven years old.

Grower: I irrigated just a few days before the freeze, on both my old and young palms. My neighbor had not irrigated for a month and his were damaged more than mine.

Nixon: The most severe damage I saw was at Sacaton, 40 miles from

Phoenix in the Gila Valley, Arizona. The palms were injured according to size and not age. The small palms were injured much more than the larger palms. Their minimum was 14°. It was 20° or below for 9 hours. Palms 15 to 25 feet high to the bud were very severely damaged, some varieties losing practically all their leaves. I have not seen anything comparable to that here. Some varieties that show up pretty well here were badly damaged there.

B. S. Boyer: Our principal interest in this subject is centered in this 1937 season, there having been no damage of equal severity in any other season since the inception of the date industry in the United States.

However, in approaching the subject, it seems well to also consider the temperatures and their effect on palms during the two cold seasons of 1913 and 1919.

For the purpose of comparison, it is well to consider the following temperature records as supplied by the Government Experiment Station here at Indio:

1913		1919		1937	
Jan. 5	30°	Dec. 31	30°	Jan. 16	28°
6	28	Jan. 1	23	17	29
7	15	2	18	18	27
8	15	3	27	19	31
9	21	4	27	20	26
10	22			21	25
11	20			22	13
12	27			23	18
13	24			24	18
14	26			25	23
				26	24

It will be seen that the seasons 1913 and 1937 are very comparable both at lowest temperatures and number of succeeding days of temperatures calculated as likely to affect the palm's ability to produce fruit.

Consideration of the 1919 season can well be dropped here because owing to the relatively high temperatures so little damage was done as to render it of no consequence.

Although 1913 and 1937 seasons are comparable as above stated the fact remains that there were so very few palms in the valley and those that were here were so very small and so few were fruiting that the economic loss was of little consequence; therefore but little attention was paid to it. Practically all of the imported palms of fruiting age were then on the Government Date Garden at Mecca and on the adjoining property of the American Date Company none of which were frozen sufficiently to detract from their ability to produce the following year.

That young palms were seriously injured in some sections of the valley was evidenced by the result on Mr. J. H. Northrop's two year old seedling planting near Indio. All the foliage on these palms was killed by the frost and later removed. There is no record of any of these palms having died; a new top having grown from the well protected terminal bud in the normal manner.

With 2919 acres (County Horticultural Inspector's figures), approximately 146,000 palms; in orchard plantings, representing a potential production of between seven and eight million pounds of fruit, the 1937 damage due to frost presents a vastly different picture.

In our experience with fruiting palms defoliated and torched in the treatment for Parlatoria scale, we found a lapse of about three years from complete defoliation to full fruiting; the first year giving no fruit, the second a very little of more or less inferior quality with the third year about normal.

On February 16, six five-year-old palms in one of the badly damaged gardens were selected for study. All of the seriously damaged foliage on these was removed leaving 22, 26, 17, 10, 13 and 12, respectively; or an average of 16 2/3 fronds. It is evident, therefore, that the shock to these palms is less than was the case in complete defoliation as in the case of treatment for Parlatoria scale. Sixteen or seventeen leaves (fronds) can reasonably be compared to the second year after torching, and a small amount of none too good fruit expected for the current season: complete recovery being realized in two years instead of three.

As has been suggested in the foregoing paragraphs, there is a great variation in the amount of damage sustained in different localities, a very few of the most favored gardens having received no appreciable injury. Considerable variation is also found in the same garden where the older and taller palms are in much better condition than the younger ...

Accepting the foregoing as a basis it would then follow that no fruit should be expected on those young palms that otherwise would have fruited this season for the first time. With the exception of the "favored" spots, the crop on the large palms should be reduced by judicious thinning. With this in mind, we should anticipate a reduced crop as compared to the 1936 yield. Of course any estimate as to the percentage of decrease is mere conjecture; but since there is more or less insistence on having a figure, I will hang up 15 to 20 per cent to be shot at.

A. J. Shamblin: Mr. Boyer and I worked together. The trees were defoliated but all bloomed next year. They couldn't keep from blooming because the flower buds were protected down in the trunk of the tree. The fruit ripened and we ate it. I have one other point. The trees that had the most leaves seem to be the least hurt.

B. Cavanagh: I was just going to remark that trees on the Krutz property were pruned quite high and had as little damage as anything around of comparable age. Also, when the tip of the midrib was frozen, altho the rest of the midrib appears to be green, when pruned the leaf base is discolored. I do not know whether this is an indication that there is no longer life in the leaf or not.

Nixon: I doubt if we could make any observations but what we could find some exceptions. I have observed some cases where having a large number of leaves did seem to afford some protection from the cold. We have to remember always that there are considerable variations occurring in the same garden within short distances. As Mr. Postlethwaite suggested, palms in different conditions would be affected in varying degrees from the cold. A large number of comparisons of varieties should be made before drawing any conclusions.

R. W. Webb: I notice that my male trees were particularly hurt. They are seedlings. I am wondering whether we will have any pollen next year.

Nixon: There is very little on record as to what followed the freeze of 1913. In the next Arizona Station report there is only brief mention of its occurrence. However, as to flowering subsequent to the freeze of 1912-13, Mr. Hilgeman called my attention this morning to a record that I had previously overlooked altho it was published in the Report of the Ninth Annual Date Growers' Institute. It was secured by the late Prof. Albert and Mr. Hilgeman in some experimental work they did in the dissection of old date palms at the Tempe Garden. I will ask Mr. Hilgeman to tell us about it.

R. H. Hilgeman: In the experiment Mr. Nixon mentioned a number of Rhars palms were dissected. After the dissection of the palm was completed we were able to determine the number of blossoms produced each year, tracing the production back to 1905. According to that record the

palms produced very few clusters in 1913, none in 1914, and a variable crop in 1915 ranging from five to eleven clusters. I have talked with the foreman of the garden at that time who stated that the palms were completely defoliated. The loss therefore was much worse than has occurred here. Doubtless the effect on the crop next year will be much less severe than that which occured at the University Date Garden.

Nixon: That bears on the problem of how many bunches to leave on this year. If defoliation prevented flowering the second year following, any fruit borne the first year would be an additional strain on the already lowered vitality of the palm. We have ample experimental evidence, also quite a bit of observational evidence, that a heavy crop one year lowers the number of flowers produced the following year. On the other hand a small crop seems to stimulate subsequent flowering. For several years at the Indio station we have cut out all but two or three flower clusters on inferior varieties. These palms have flowered regularly in the spring and often in the summer have had several off-season blooms. Hence all the evidence would indicate that the crop allowed to remain on the palms this year should be reduced in proportion to the reduction in leaves.

To summarize: the results of the January freeze indicate that right around 20° F. is the danger point for injury to date palms. In no instance have I observed damage to dates when the minimum temperature was above 20°. At Death Valley a minimum temperature of 21° was recorded. They have young palms of the Khadrawy and Halawy there, varieties elsewhere shown to be relatively susceptible to injury from low temperatures, but there was no damage. On the other hand at the Rancho Santa Maria near Marinette, Arizona, a minimum of 20° for 1¾ hours reduced the leaf area 50 per cent or more on four year old palms of Maktoom, Sayer and Khalasa.

Mr. Postlethwaite has called attention to the fact that young offshoots wrapped showed less damage than those not wrapped. I observed this in a number of instances and I suspect that it would be the better part of wisdom to come back to that practice which many growers have abandoned during the past few years. Mr. Dowson told us last spring that if offshoots in Iraq were not wrapped for the first year after being set out they would certainly be killed by cold weather in winter if not injured by heat in summer.

Among the varieties least damaged by the freeze were: Zahidi, Ashrasi, Deglet Noor, Thoory, Dayri, Tazizoot, Hayany, Iteema and Saidy. I do not know the extent to which susceptibility to damage from low temperatures depends on qualities inherent in the variety. It may be of interest to note that the Zahidi, which was probably injured less than any other variety, is grown farther north in Iraq and adjacent portions of Persia than any other variety in that region. At least with some of the varieties peculiarities of the crown and leaves may offer a partial explanation of their varying susceptibilities to cold. The Zahidi has a particularly compact crown. Halawy and Khadrawy have a long spine area and open center resulting in much greater exposure. A pronounced curvature of the leaves as in the Saidy also results in greater exposure. I was started to thinking along this line by what happened to a row of old Tazizoot palms at the U. S. Experiment Date Garden. This variety has short fruit stalks and leaves below last year's fruit bunches had been pulled down so that there is quite a gap between the upper part of the crown and the lower part. It was quite obvious that leaves adjacent to that gap were more severely damaged by the freeze than those immediately above or below the most exposed leaves.

Kinnison: This brings to a conclusion the program of the 14th annual Date Institute. Next year you will know more about the effects of those low temperatures. To me this meeting has been very interesting, and again I wish to express my appreciation of the opportunity to be with you. The Agricultural Extension Service and the date growers are to be congratulated on the program. The topics have been pertinent and papers excellently presented. I am sure we will all join in thanking the men who have prepared this program for their efforts.